

(21) Application No 9219791.2

(22) Date of filing 18.09.1992

(30) Priority data

(31) 03241101  
03272321

(32) 20.09.1991  
21.10.1991

(33) JP

(71) Applicant

Hitachi, Ltd.

(Incorporated in Japan)

6 Kanda Surugadal 4-chome, Chiyoda-ku, Tokyo,  
Japan

(72) Inventors

Naoko Yamazaki  
Itsuko Kluchi  
Hiromichi Fujisawa  
Tetsuya Hashimoto

(74) Agent and/or Address for Service

Mewburn Ellis  
2 Cursitor Street, London, EC4A 1BQ, United Kingdom

(51) INT CL<sup>6</sup>

G06F 15/40

(52) UK CL (Edition L)

G4A AUDB

(56) Documents cited

US 4611298 A

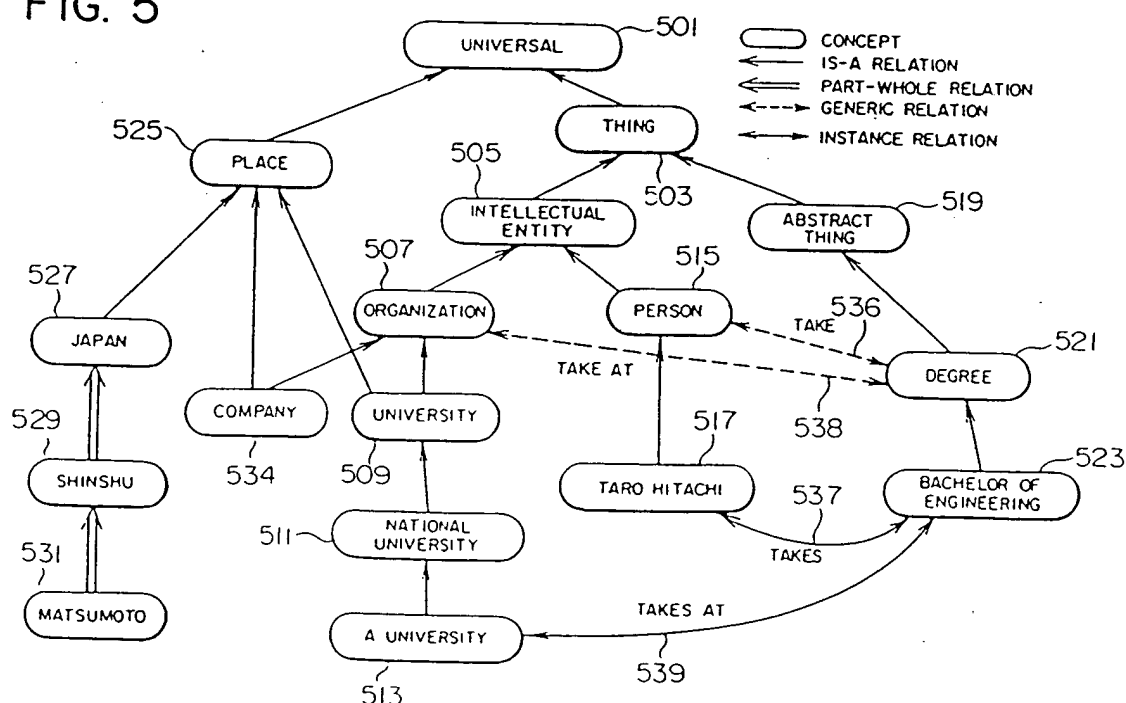
(58) Field of search

UK CL (Edition K) G4A AUD  
INT CL<sup>6</sup> G06F 15/40

(54) Information storage/retrieval system and display method

(57) An information storage and retrieval system stores fact information represented in terms of conceptual concepts expressing things and relational concepts expressing relations therebetween. The system includes a device for inputting fact information with respect to a specific relational concept according to a template pattern by using a multi-window function on the basis of information obtained from a concept dictionary for defining hierarchical relations between concepts and a grammar rule for defining semantic structures of cases and concepts allowed to be used in the cases, and a device for displaying fact information in a fact window and displaying a hierarchy of conceptual concepts and relational concepts in a node tree window.

FIG. 5





# FIG. 1

VIEW
FONT

UNIVERSAL
112

CONCEPT
113

INTELLECTUAL ENTITY
114

ORGANIZATION
115

COMPANY
116

VIEW
108

IT HAS [OFFICE] IN [SHINSHU].
120

IT WAS REBUILT BY [PERSON].
109

IT PUBLISHED [ESSAY] [MAGAZINE].
110

IT BOUGHT [ISLAND] IN [TIME].
111

QUIT
VIEW
EDIT

117
118
119

INTE-  
LLLECTUAL  
ENTITY
ORGANI-  
ZATION
COMPANY

FINANCIAL BUSINESS
CONSTRUCTION BUSINESS
MAKER

NATIONAL UNIVERSITY
PUBLIC UNIVERSITY

1
IS-A

2
> NATIONALITY >

3
> BIRTHPLACE >

4
< DESIGNER-OF <

5
.....

PERSON
JAPAN

KANAGAWA
PREFECTURE

Mr. KATAGIRI'S
RESIDENCE

1
TARO HITACHI GRADUATED UNIV. A IN 1970

4
TARO HITACHI TOOK DOCTORATE AT UNIV. B IN 1975

6
(SET TARO HITACHI, YOSHIO TANAKA) SETUP OFFICE IN KOBUCHIZAWA

25
SUZUKI TRADE CO ASKED TARO HITACHI TO BUILD 14TH OCHANOMIZU BUILDING

UNDER
CONCEPT

FIG. 2

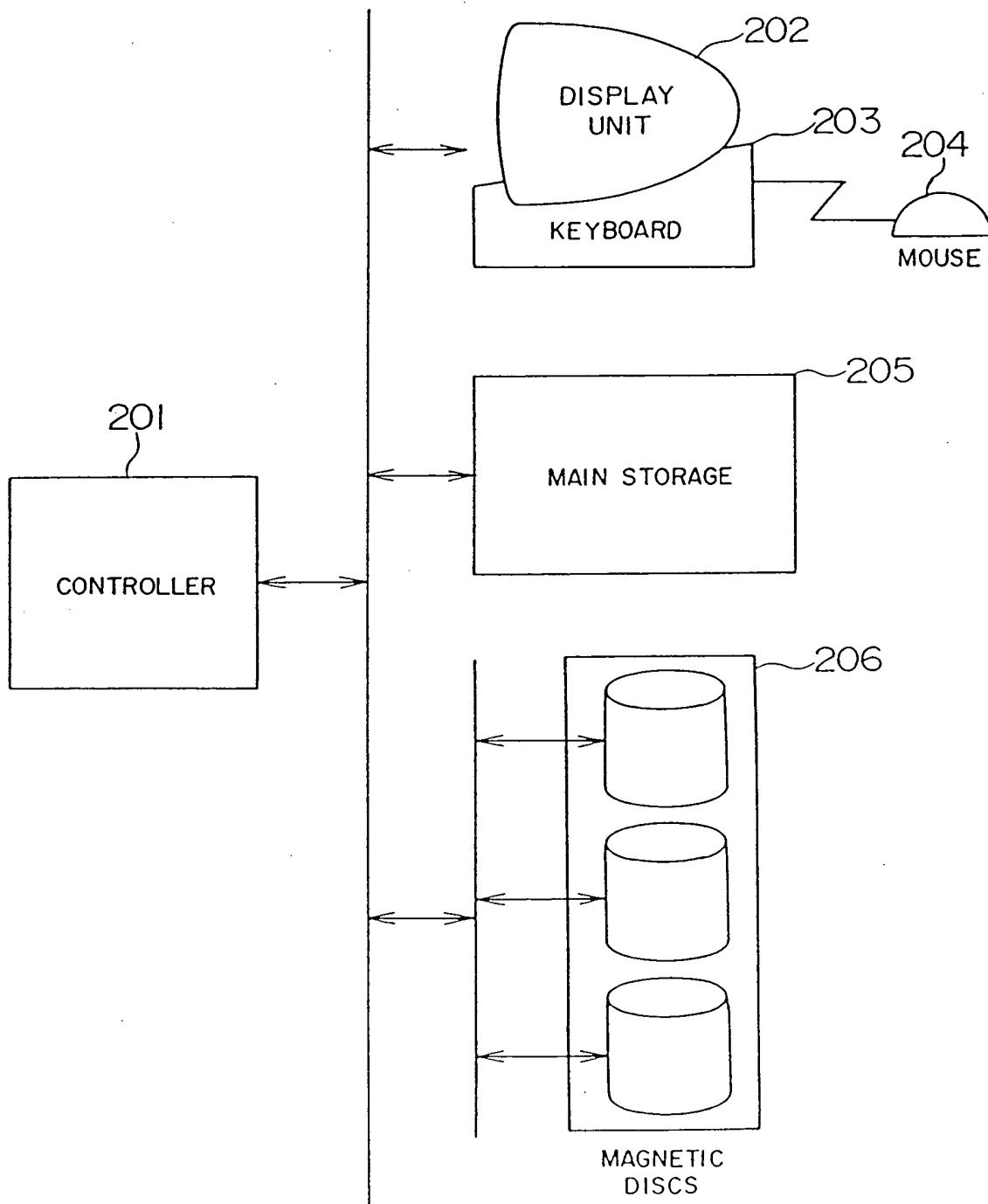


FIG. 3

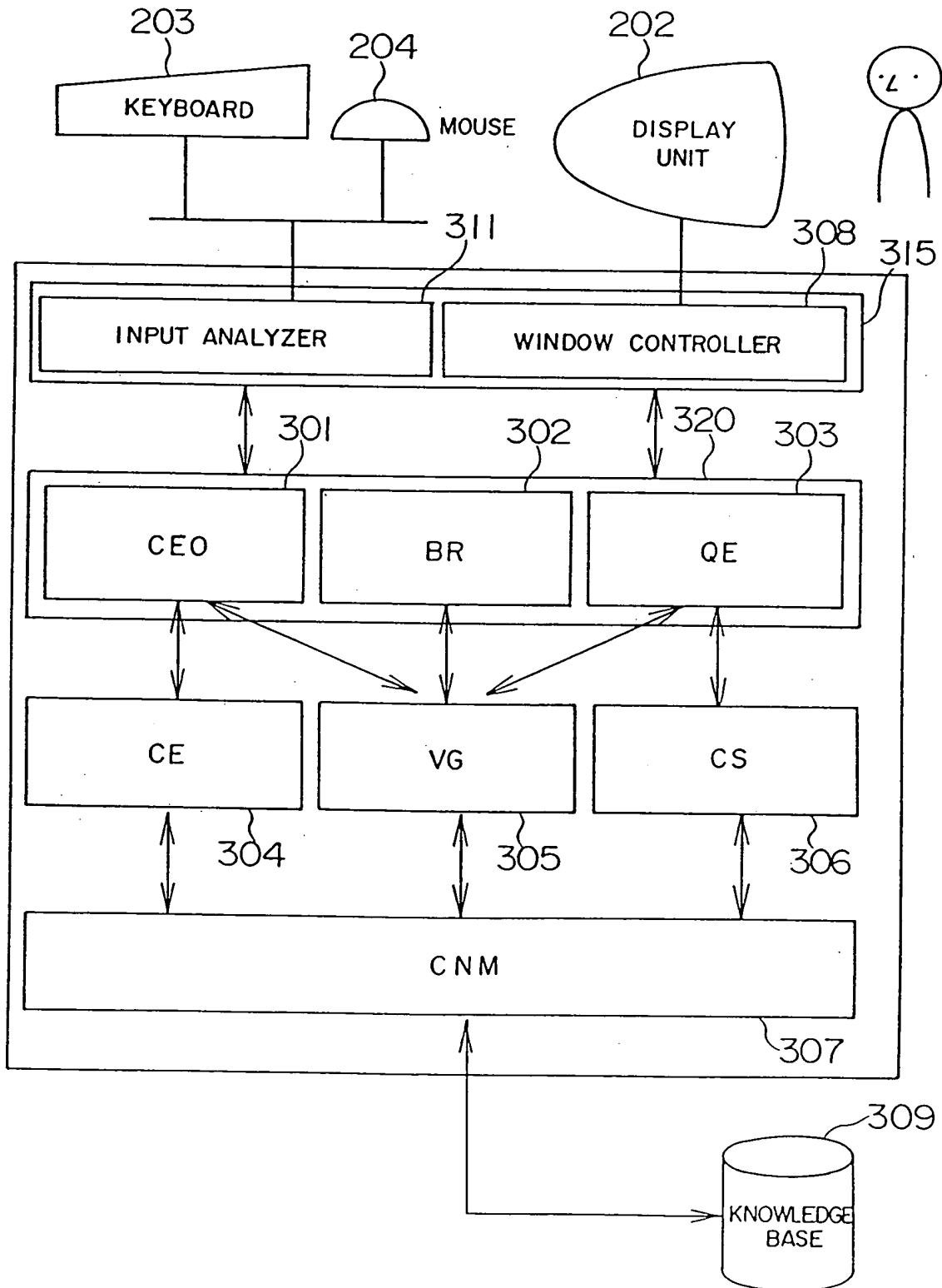


FIG. 4

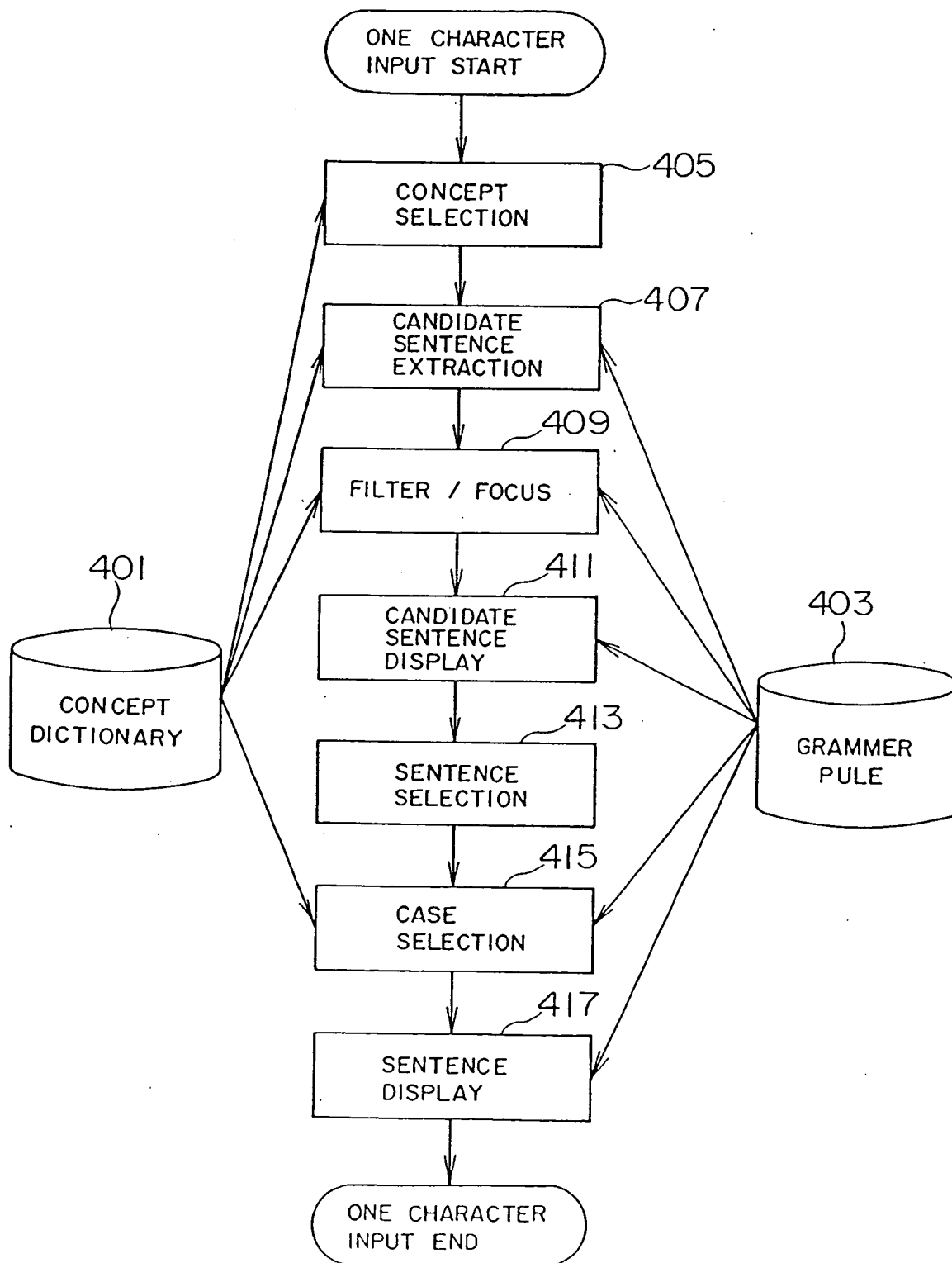
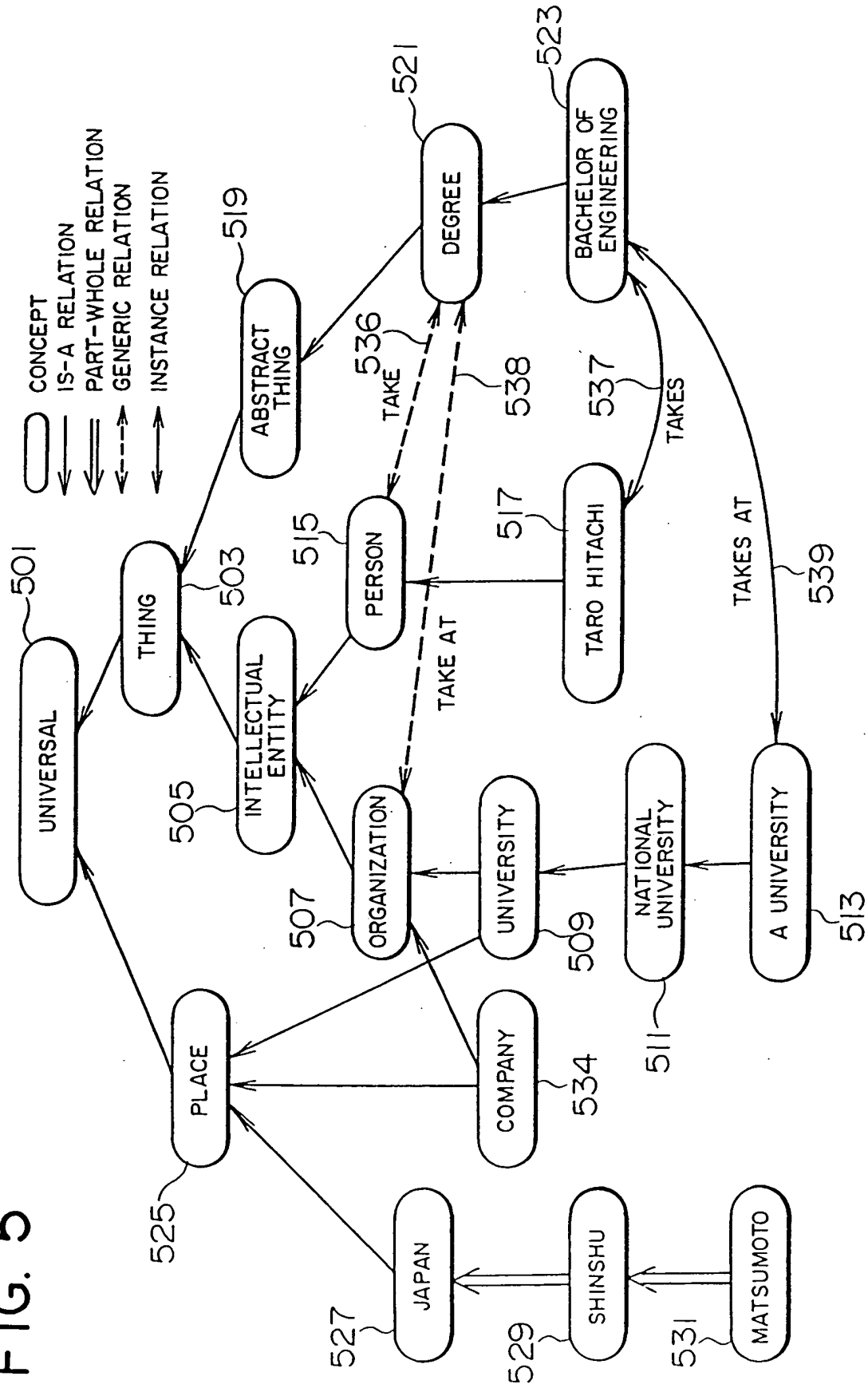
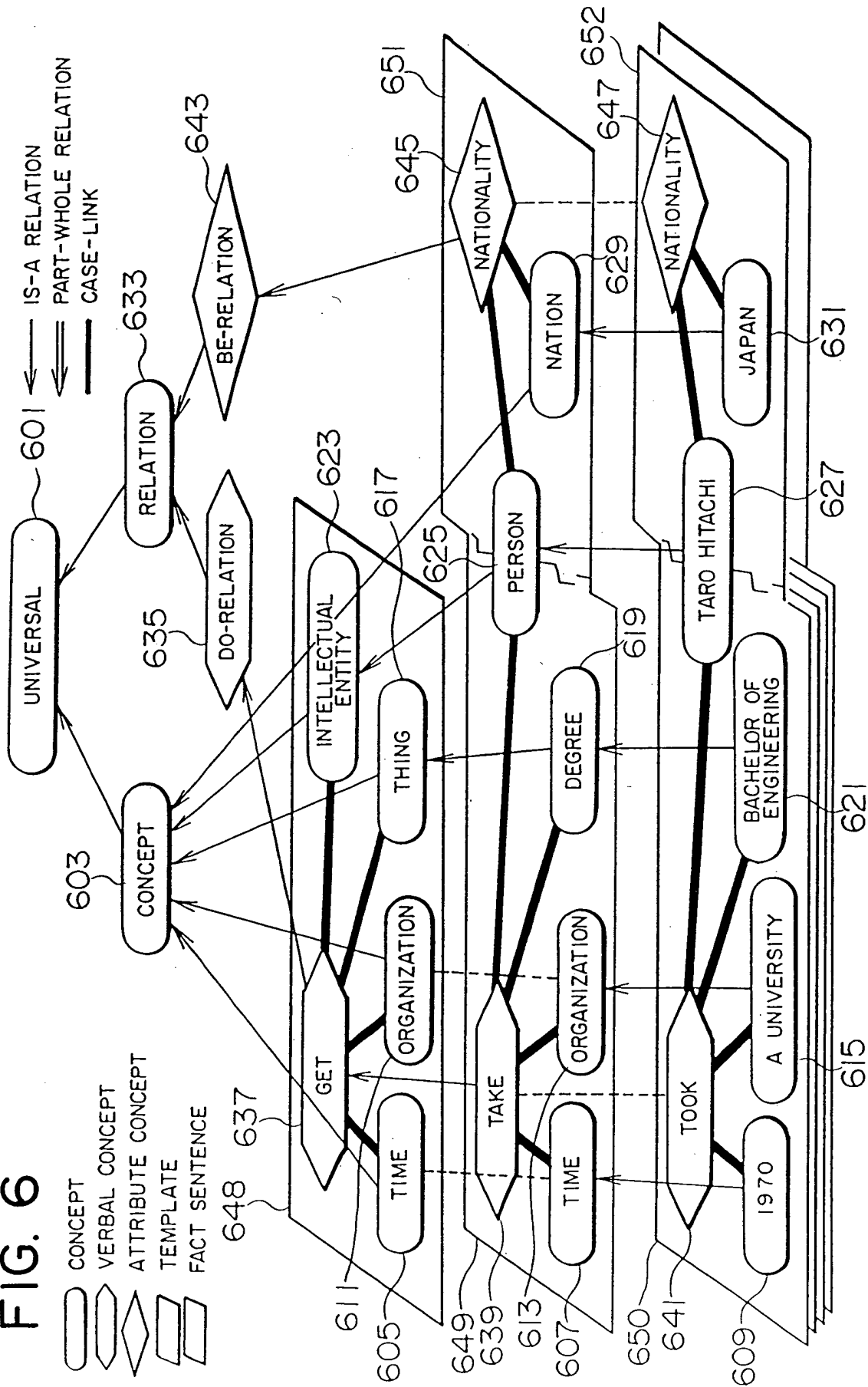


FIG. 5



உ







# FIG. 8

801

VIEW

UNIVERSAL

CONCEPT

INTELLECTUAL ENTITY

ORGANIZATION

COMPANY

VIEW

FONT

[COMPANY]:?

IT HAS [OFFICE] IN [SHINSHU].

IT WAS REBUILT BY [PERSON].

802

RESULT 3 CASES

VIEW

SELECTION

CLOSE

☒ SHINSHU IMMOVABLES COMPANY

☐ AZUMA, CO., LTD.

☐ KAWASE IMMAVALES

810

INTELLECTUAL ENTITY

ORGANIZATION

PERSON

CLOSE

VIEW

1. SHINSHU IMMOVABLES CO., LTD.:

IT HAS SHINSHU NAGANO OFFICE IN NAGANO-SHI.

IT WAS REBUILT BY TARO HITACHI.

811

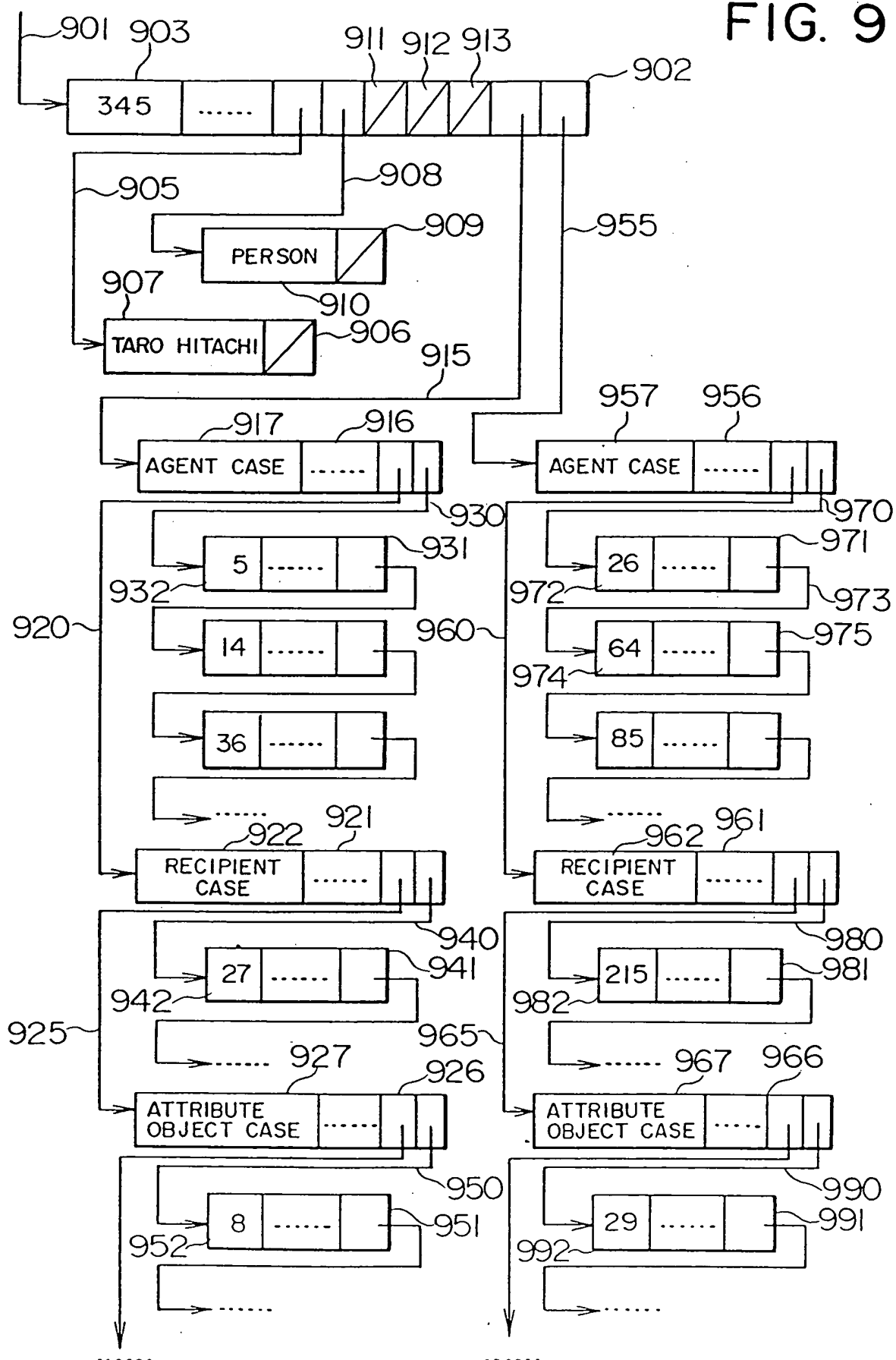
SEARCH CONCEPT

UNDER

CONCEPT

2/72

FIG. 9



10/72

FIG. 10

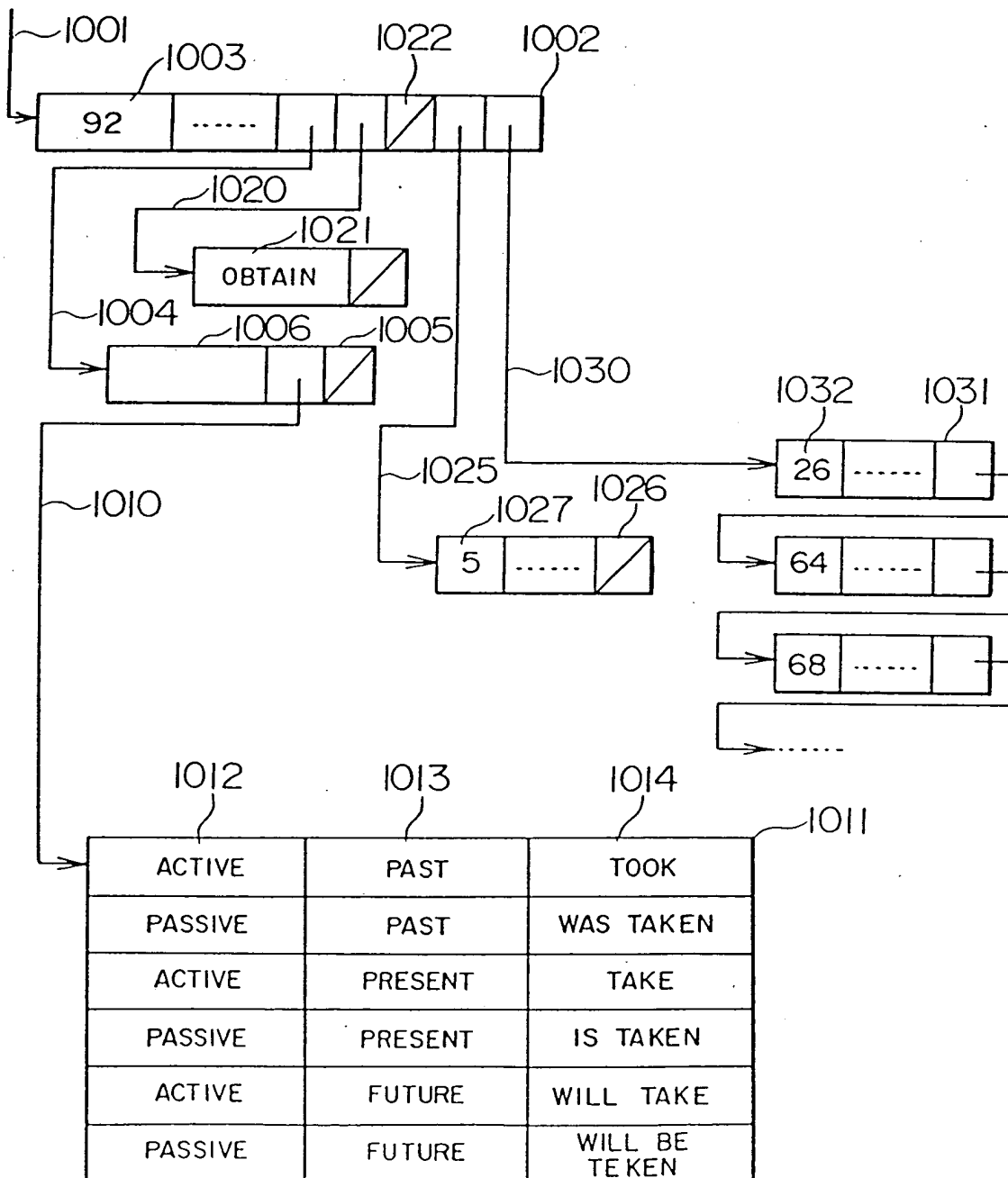
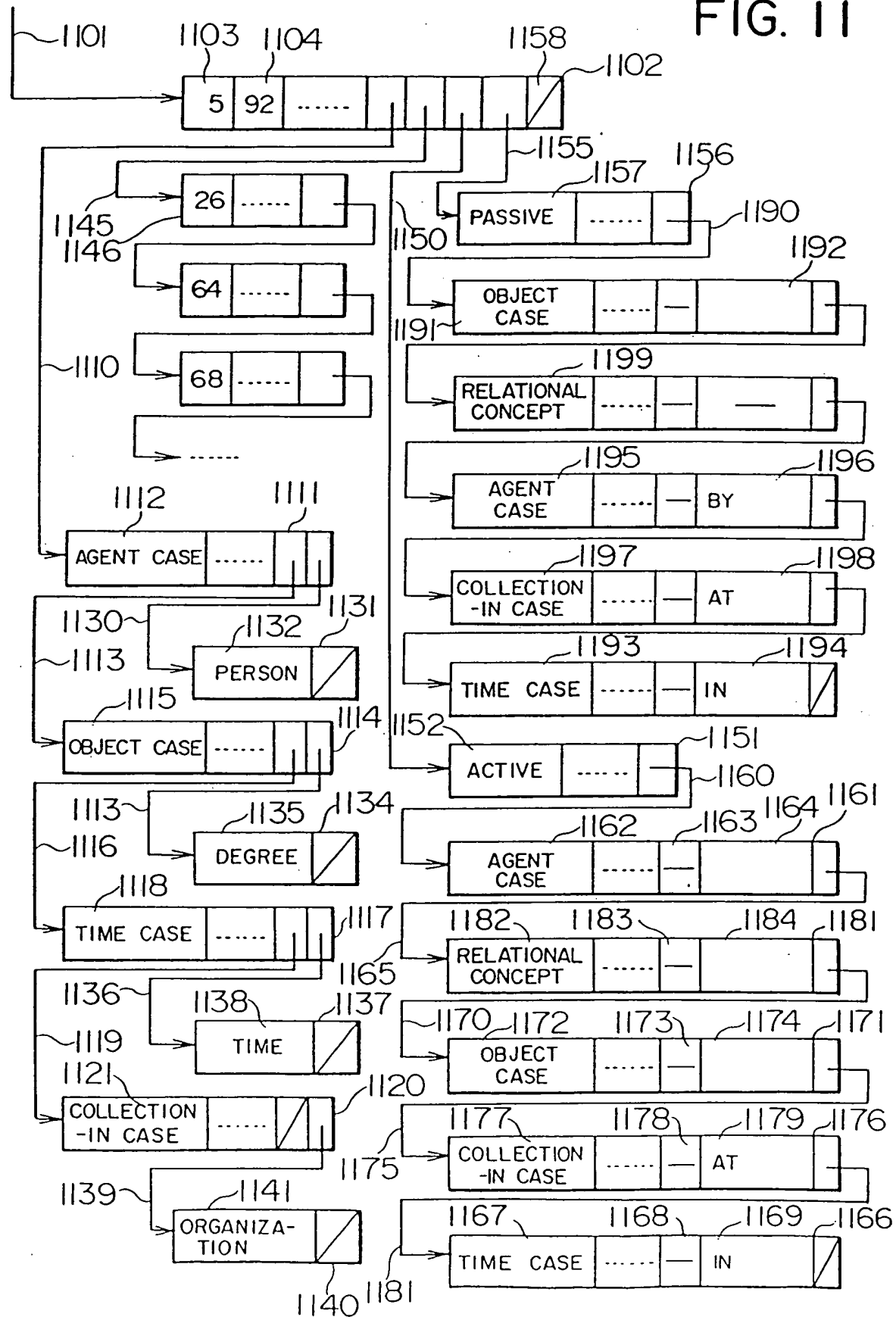


FIG. 11



# FIG. 12

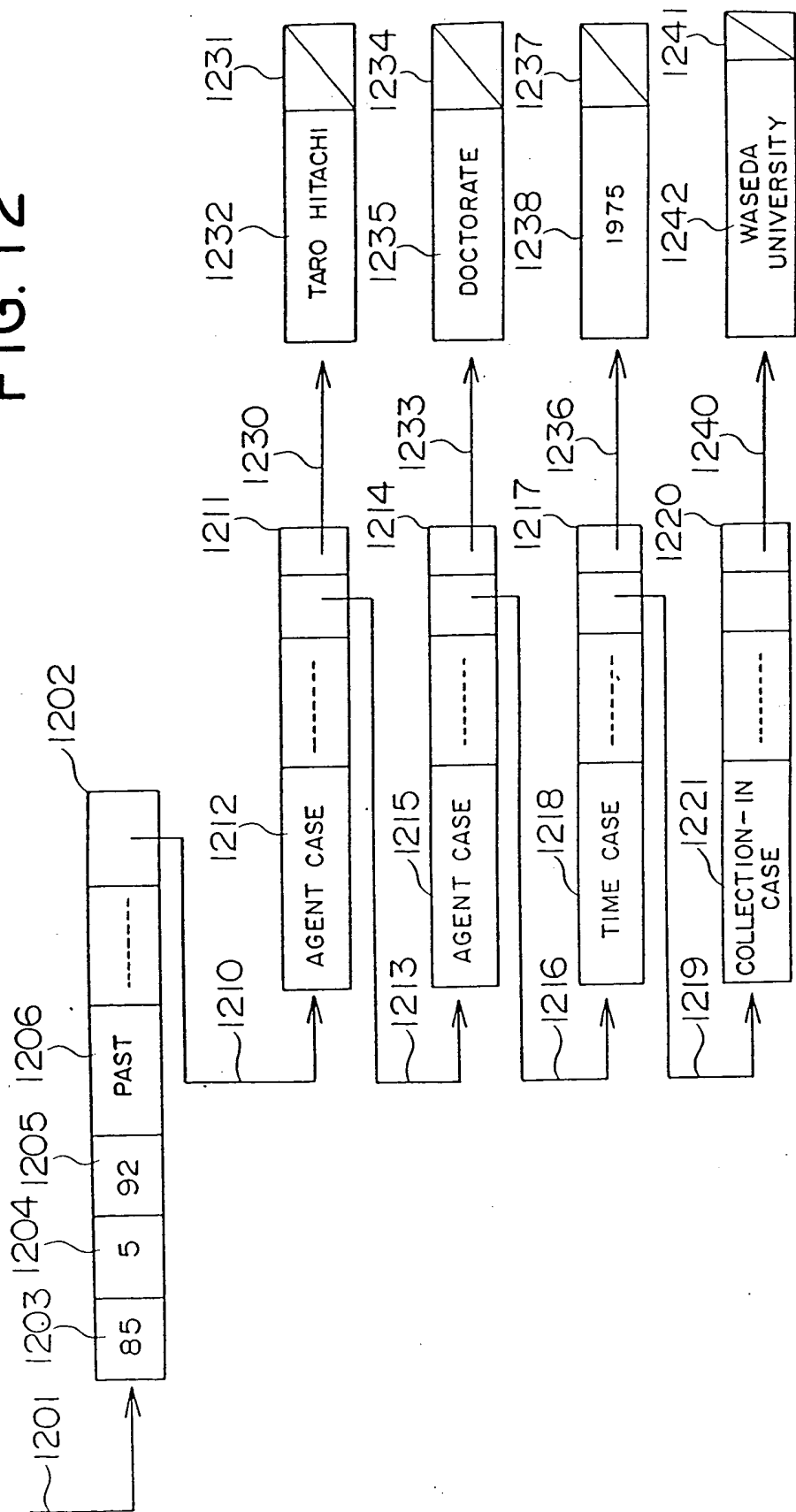


FIG. 13

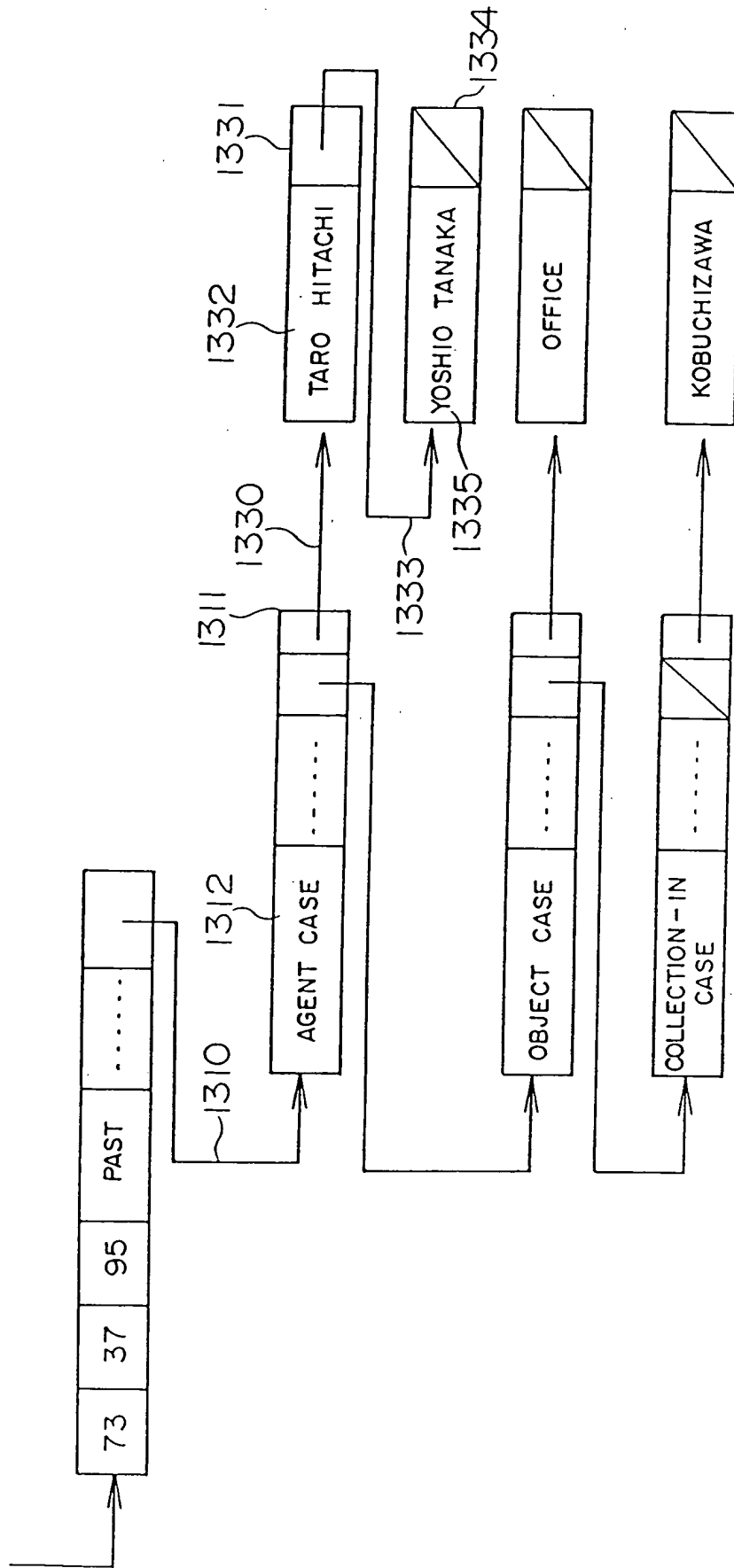


FIG. 16

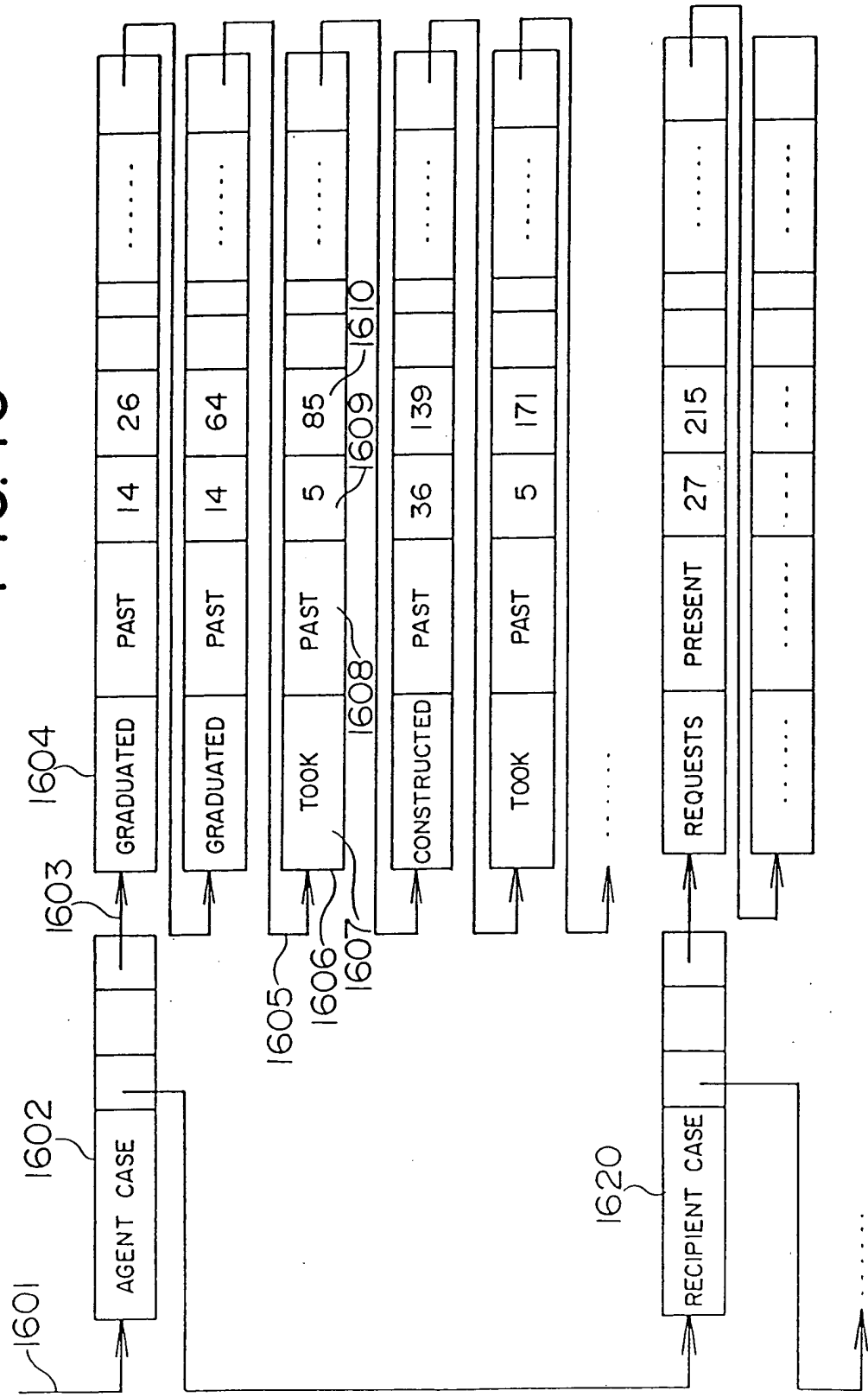




FIG. 17

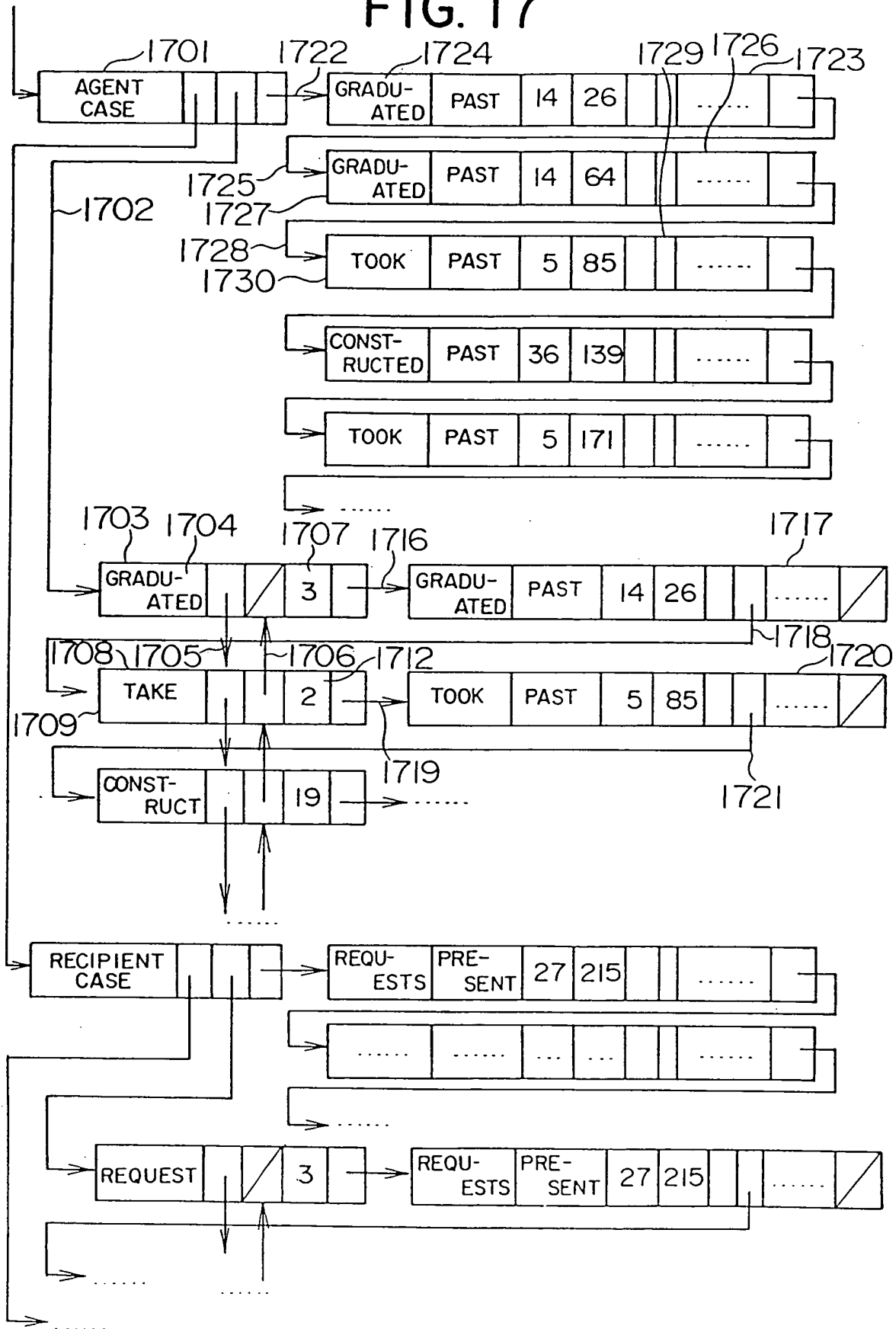
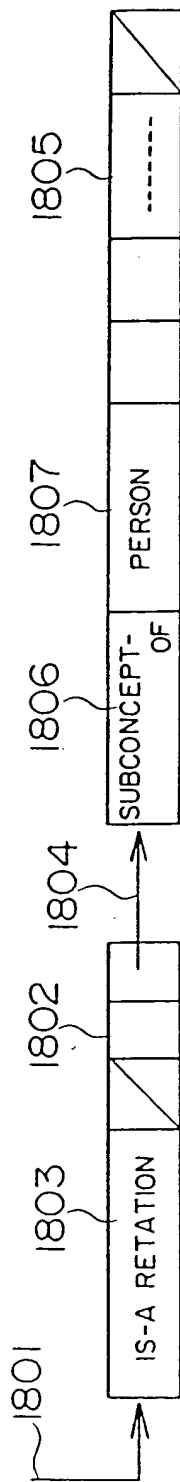


FIG. 18

IS "SUBCONCEPT-OF" CORRECTED ?







2172

FIG. 21

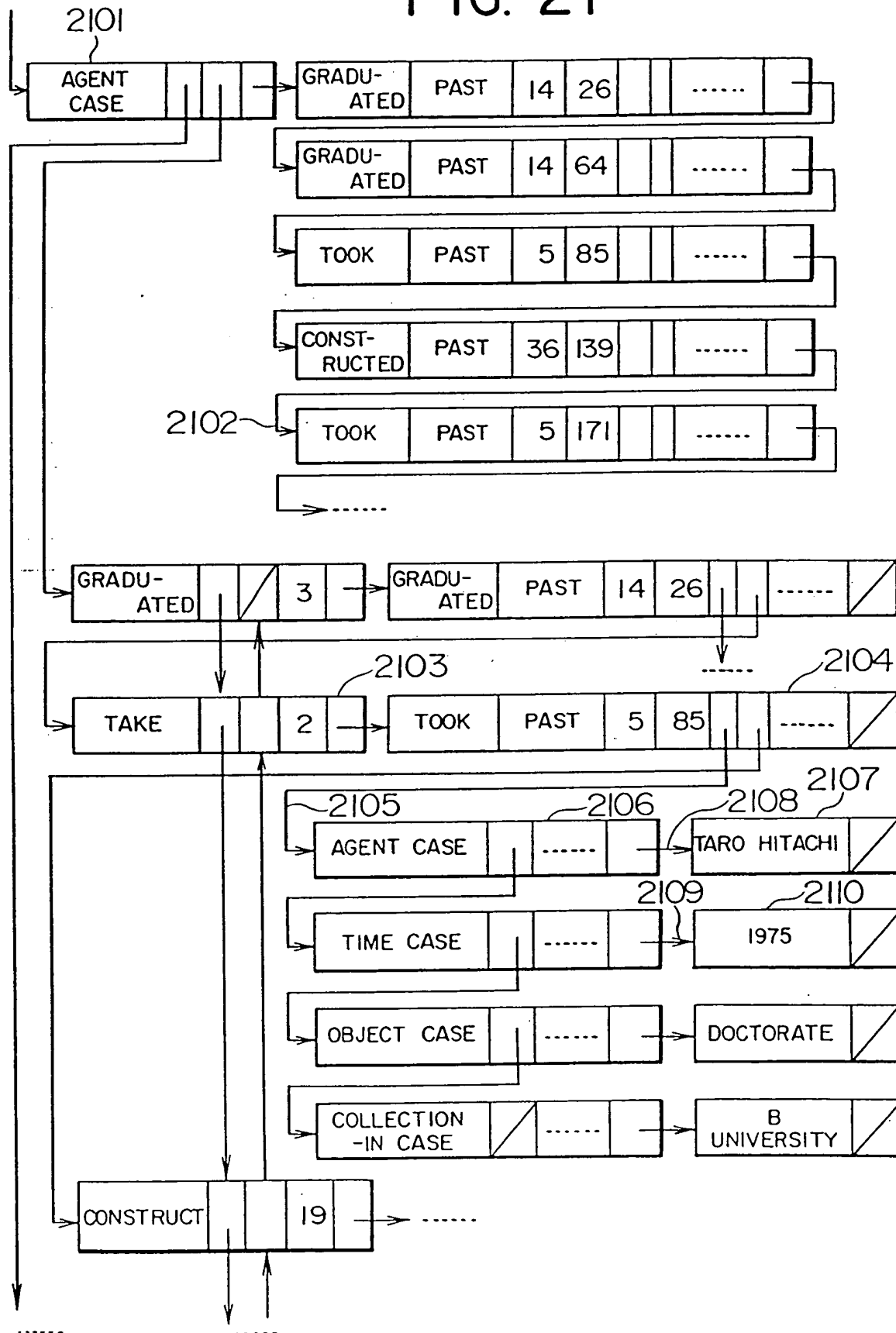




FIG. 23

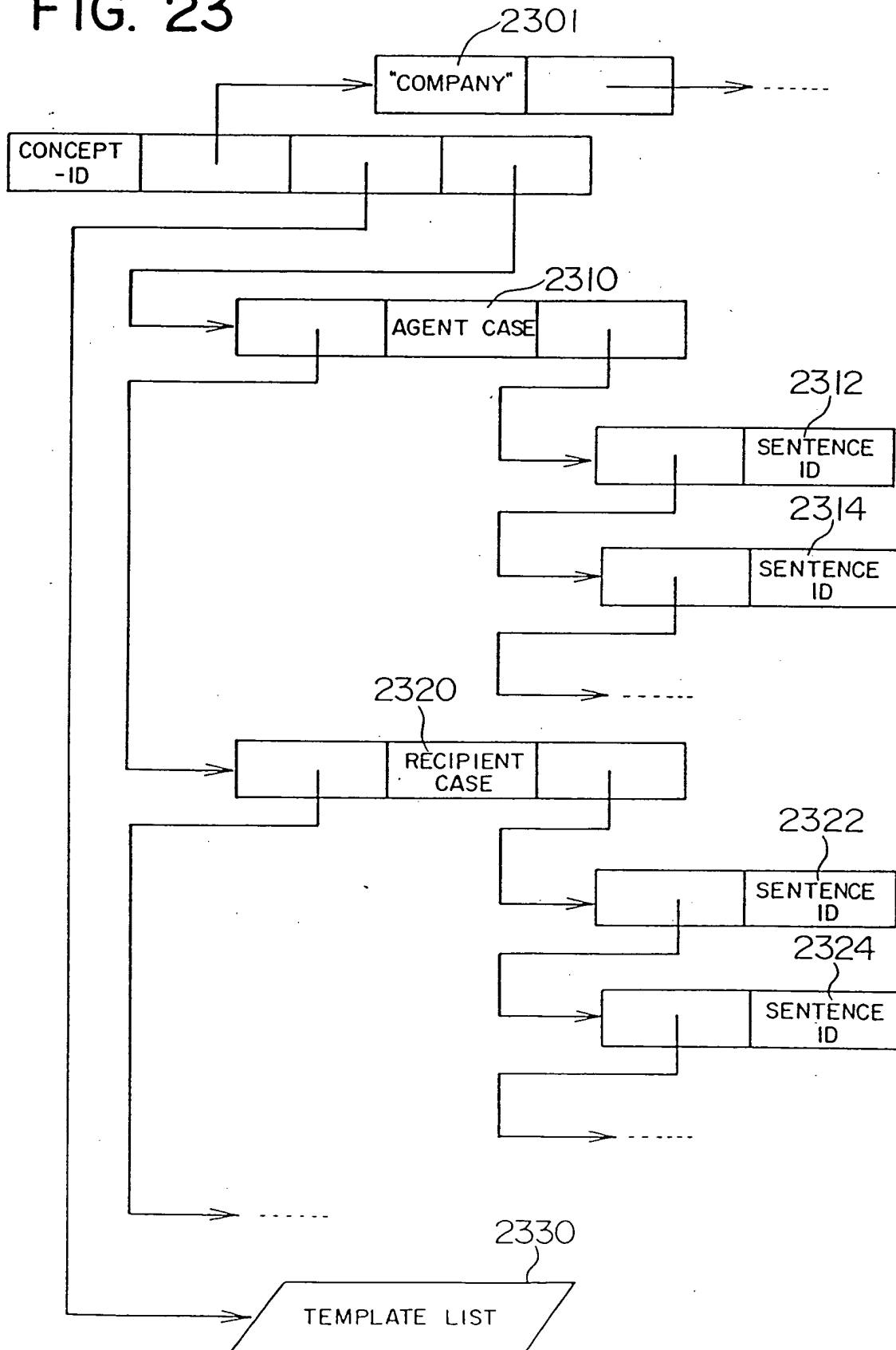


FIG. 24

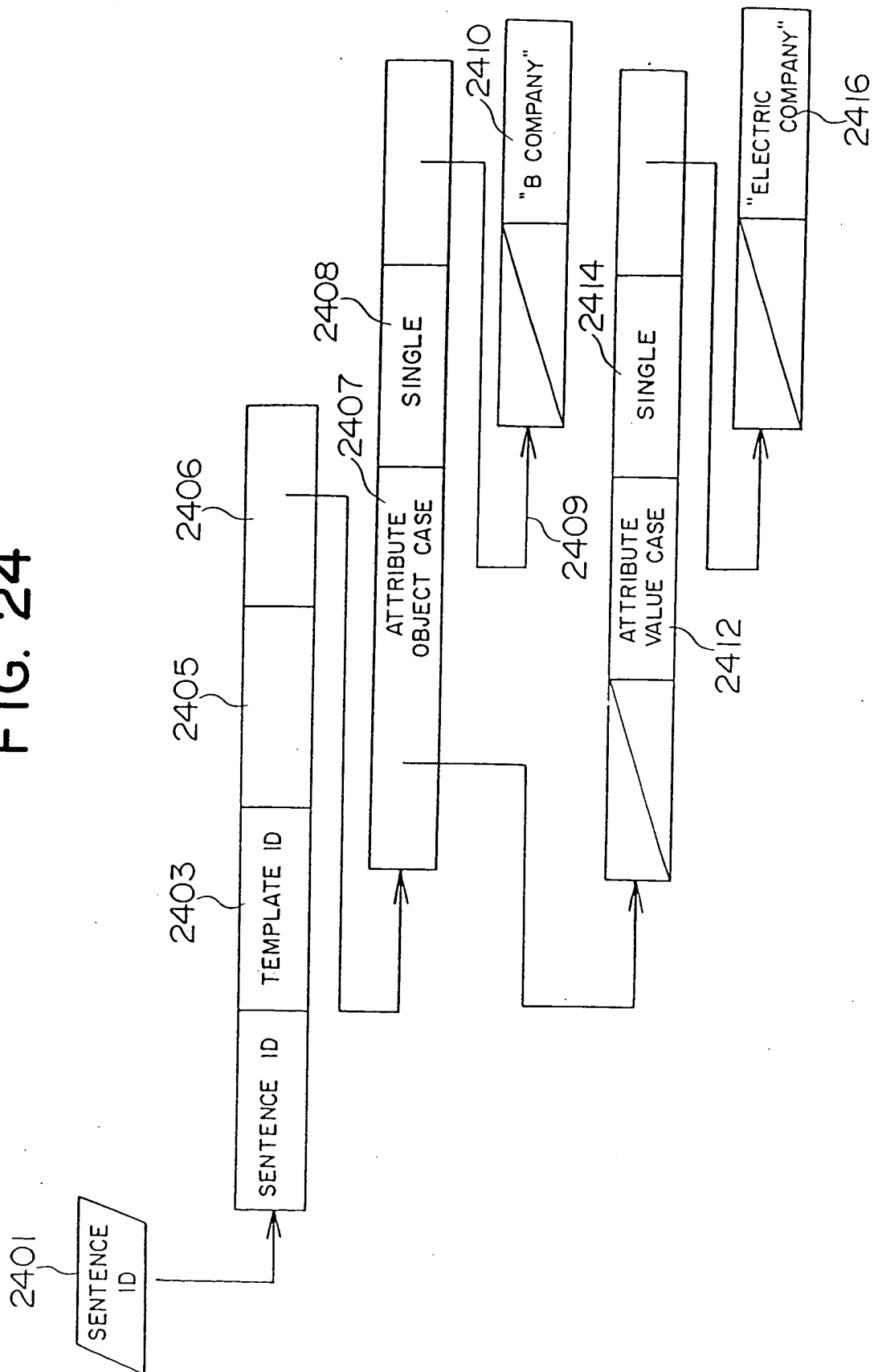




FIG. 25

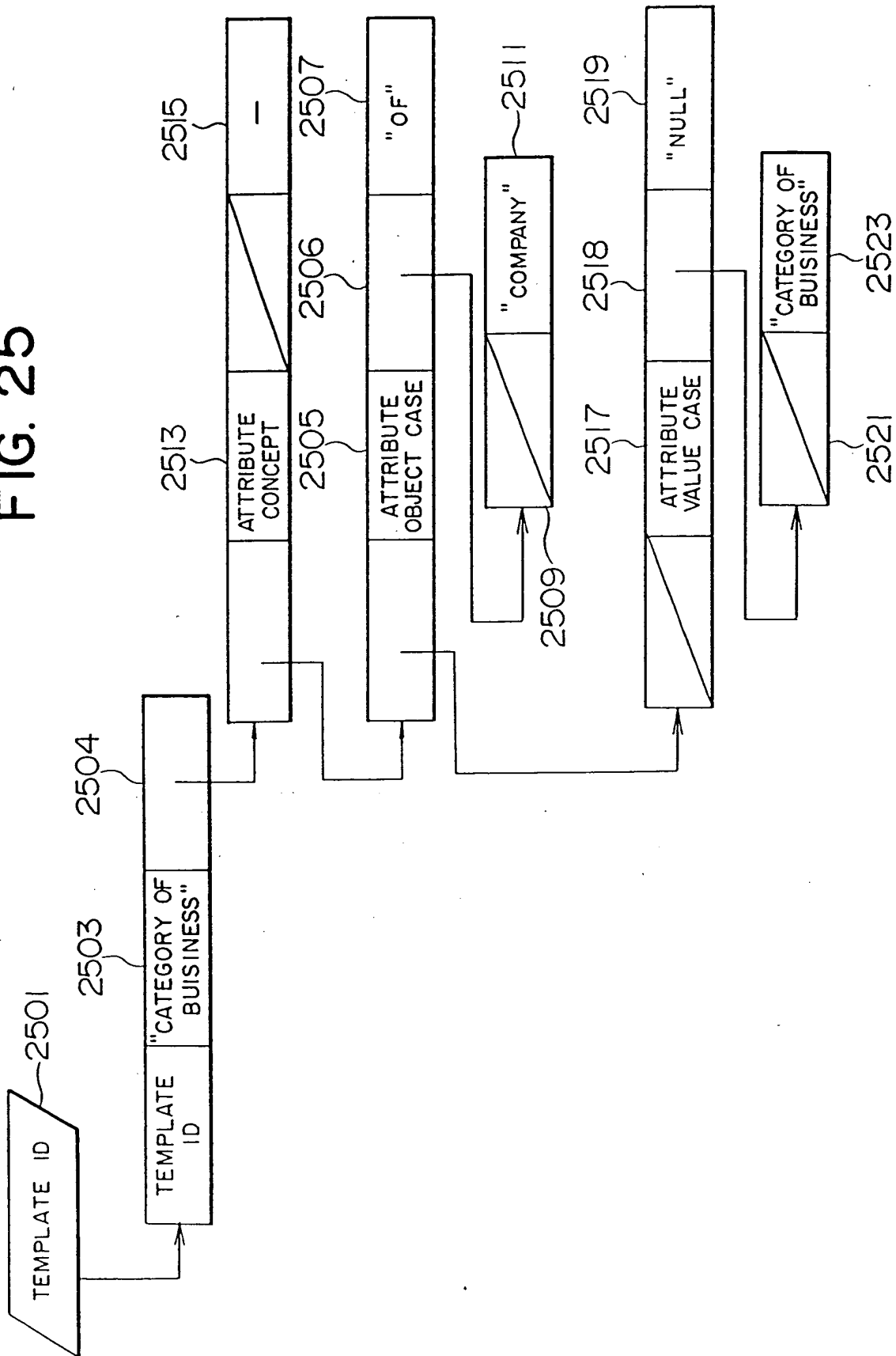
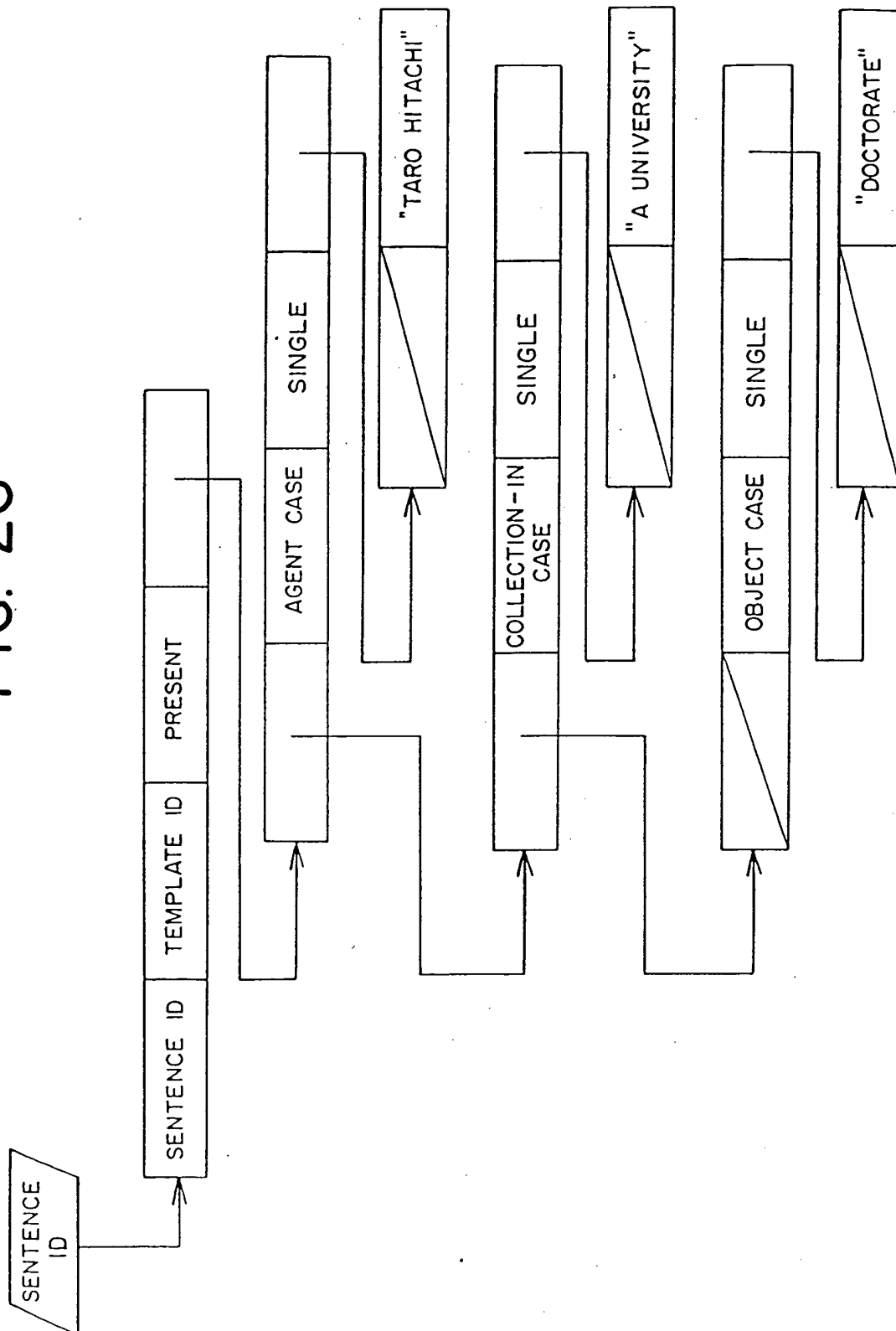


FIG. 26



27/72

FIG. 27

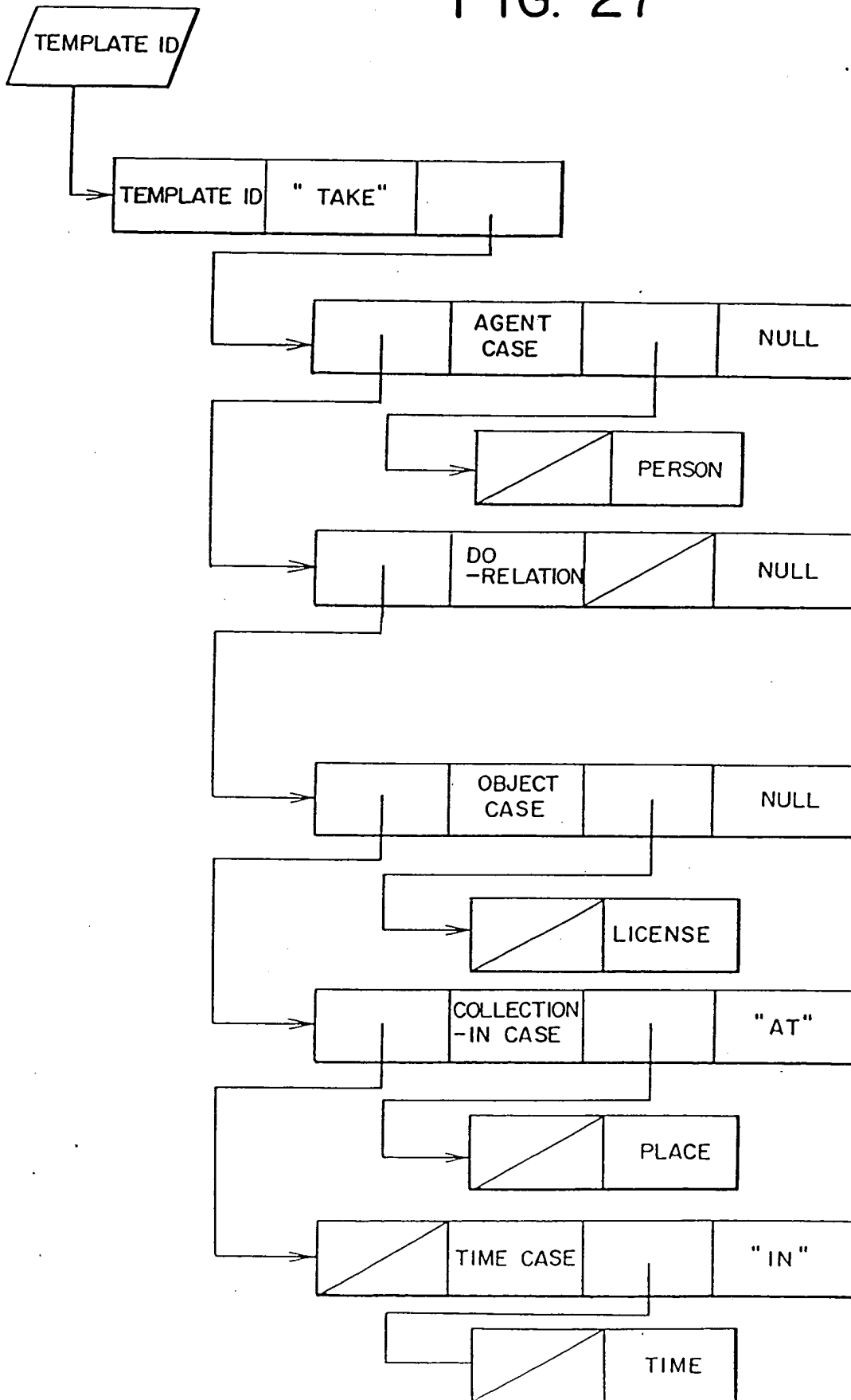


FIG. 28

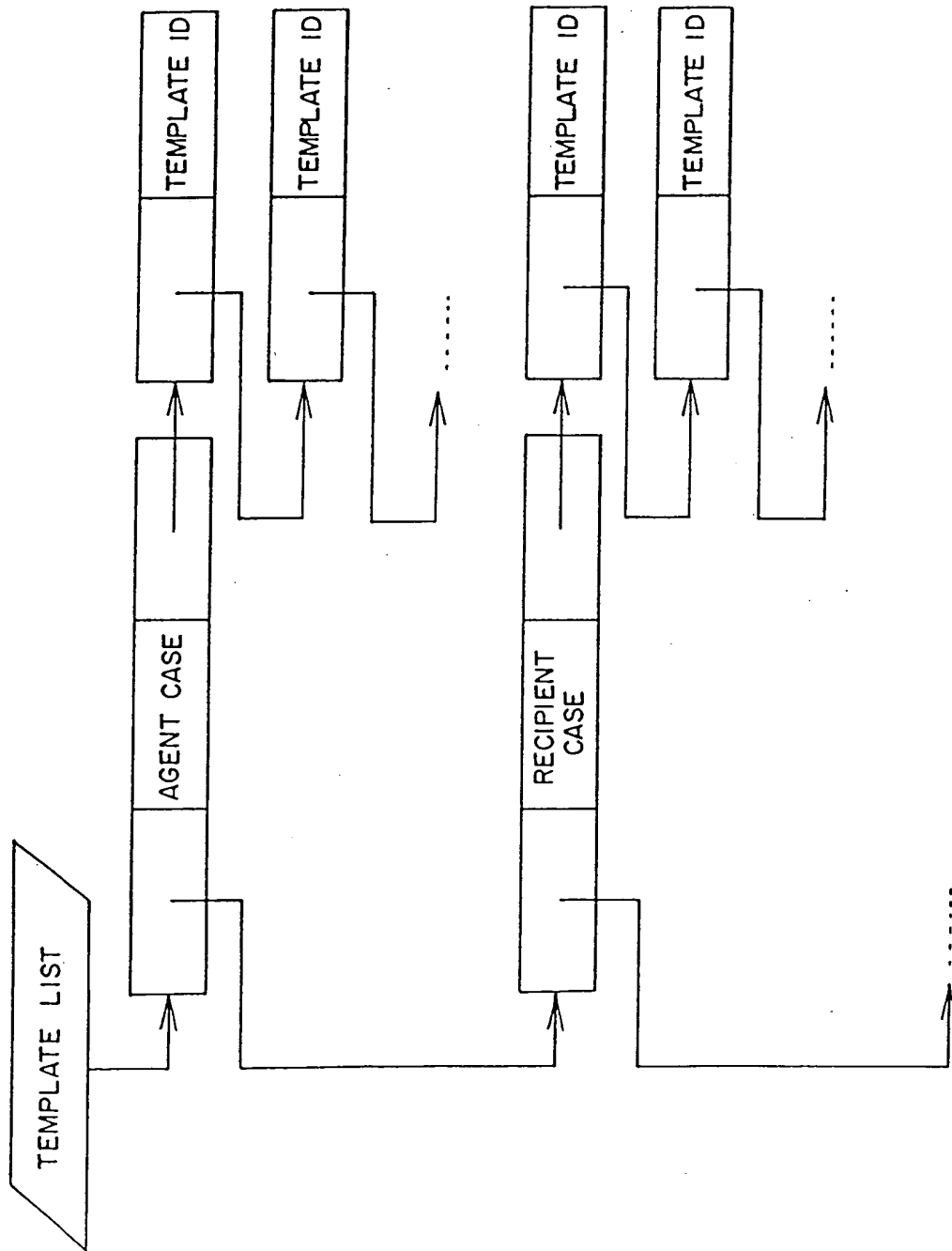




FIG. 30

| < TAKE > |  | VIEW | REGISTER | CLOSE |
|----------|--|------|----------|-------|
| 1        | TARO HITACHI TOOK DOCTORATE AT UNIV. B IN 1975.    |      |          |       |
| 2        | TARO HITACHI TOOK BACHELOR OF ENGINEERING IN 1970. |      |          |       |
| 3        | YOSHIO TANAKA TOOK LICENSE OF ARCHITECT.           |      |          |       |
| 4        | REIKO SAGAWA TOOK LICENSE OF FLOWER DESIGNER.      |      |          |       |
| 5        | YOJI MORIYAMA TOOK LICENSE OF PHARMACEUTIST.       |      |          |       |

30/72

3001

3002

3003

# FIG. 31

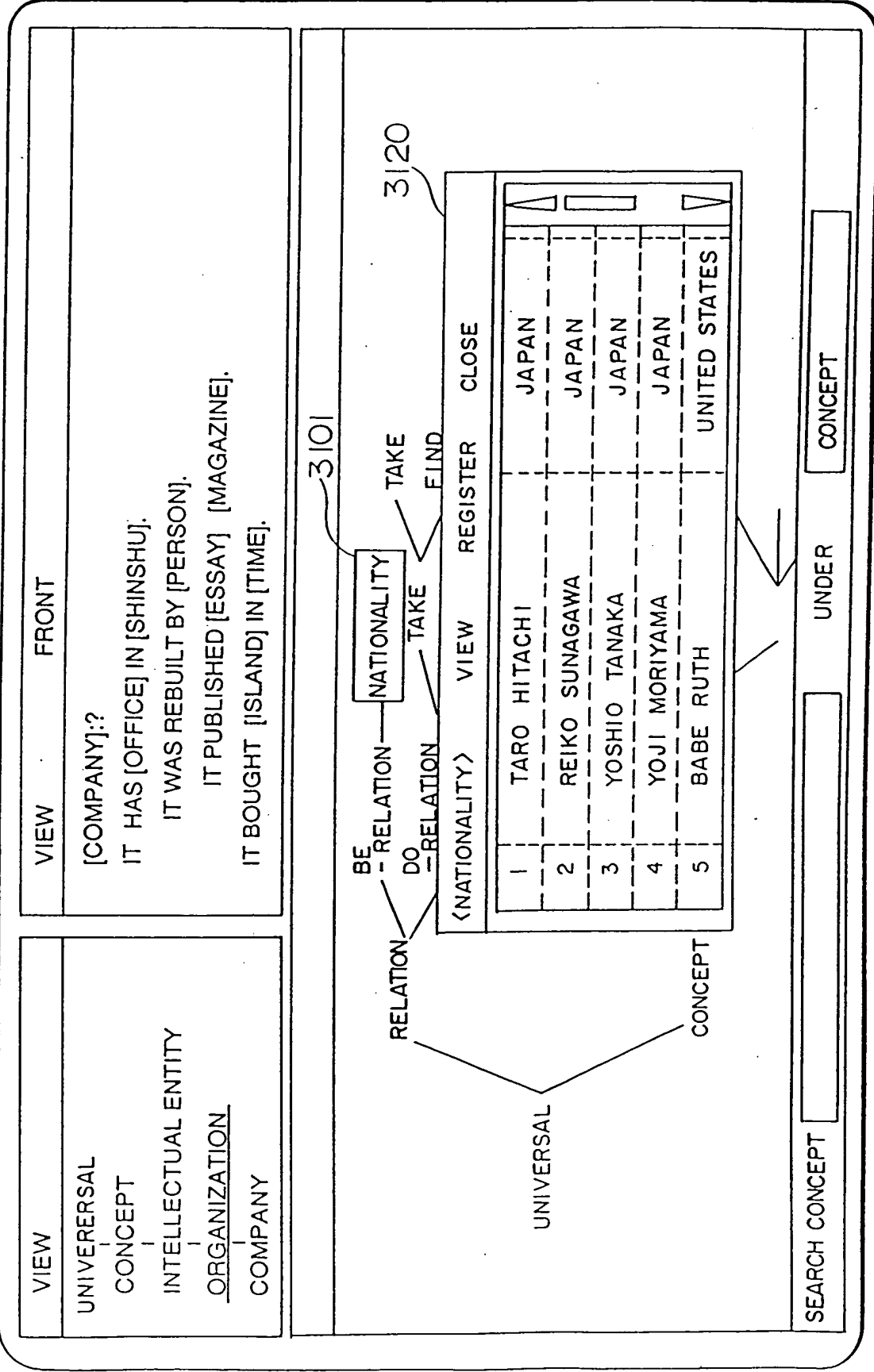


FIG. 32

| < NATIONALITY > |   | VIEW          | REGISTER      | CLOSE |
|-----------------|---|---------------|---------------|-------|
| 3201            | 1 | TARO HITACHI  | JAPAN         | 3205  |
| 3202            | 2 | REIKO SAGAWA  | JAPAN         | 3206  |
| 3203            | 3 | YOSHIO TANAKA | JAPAN         | 3207  |
| 3204            | 4 | YOJI MORIYAMA | JAPAN         | 3208  |
|                 | 5 | BABE RUTH     | UNITED STATES |       |

22/72



# FIG. 33

VIEW

UNIVERSAL  
CONCEPT  
INTELLECTUAL ENTITY  
ORGANIZATION  
COMPANY

VIEW

[COMPANY] : ?

IT HAS [OFFICE] IN [SHINSHU].

IT WAS REBUILT BY [PERSON].

3303

< TAKE >

VIEW

REGISTER

CLOSE

☐

TARO HITACHI TOOK DOCTORATE AT UNIV. B IN 1975.

☐

TARO HITACHI : TOOK BACHELER OF ENGINEER AT TOHOKU UNIV. IN 1970.

3302

INTELLECTUAL  
ENTITY

< TARO HITACHI >

VIEW

REISTER

CLOSE

3301

1

IS-A

PERSON

2

> NATIONALITY >

JAPAN

3

> BIRTHPLACE >

KANAGAWA  
PREFECTURE

4

< DESIGNER-OF <

Mr. KATAGIRI'S  
RESIDENCE

5

.....

.....

1

TARO HITACHI GRADUATED UNIV. A IN 1970

4

TARO HITACHI TOOK DOCTORATE AT UNIV. B  
IN 1975

6

(SET TARO HITACHI, YOSHIO TANAKA) SETUP OFFICE  
IN KOBUCHIZAWA

25

SUZUKI TRADE CO. ASKED TARO HITACHI TO BUILD  
4TH OCHANOMIZU BUILDING

SEARCH CONCEPT

UNDER

CONCEPT

FIG. 34

3401

| < TAKE >                 | VIEW   | RESISTER | CLOSE |
|--------------------------|--|----------|-------|
| <input type="checkbox"/> | TARO HITACHI: TOOK DOCTORATE AT UNIV. B IN 1975            |          |       |
| <input type="checkbox"/> | TARO HITACHI: TOOK BACHELER OF ENGINEER AT UNIV. A IN 1970 |          |       |

3402

3403

3404

FIG. 35

35/72

| <TAKE >                  | VIEW  | RESISTER | CLOSE |
|--------------------------|---|----------|-------|
| <input type="checkbox"/> | TARO HITACHI : TOOK DOCTORATE AT UNIV. A IN 1975            |          |       |
| <input type="checkbox"/> | TARO HITACHI : TOOK BACHELOR OF ENGINEER AT UNIV. A IN 1970 |          |       |

3501

# FIG. 36

3601

< TARO HITACHI >

VIEW

|   |                 |                             |
|---|-----------------|-----------------------------|
| 1 | IS-A            | PERSON                      |
| 2 | > NATIONALITY > | JAPAN                       |
| 3 | > BIRTHPLACE >  | KANAGAWA<br>PREFECTURE      |
| 4 | < DESIGNER-OF < | Mr. KATAGIRI'S<br>RESIDENCE |
| 5 | -----           | -----                       |

RESISTER

CLOSE

3604

|   |   |
|---|---|
| 1 | TARO HITACHI GRADUATED UNIV. A IN 1970                                |
| 4 | TARO HITACHI TOOK DOCTORATE AT UNIV. B IN 1975                        |
| 5 | TARO HITACHI : TOOK BACHELOR OF ENGINEER AT UNIV. A IN 1970           |
| 6 | SUZUKI TRADE CO. ASKED TARO HITACHI TO BUILD 14TH OCHANOMIZU BUILDING |

3606 3605

3602 3603

# FIG. 37

3703
3701 3702

|    | < PERSON >      | VIEW                | RESISTER   | CLOSE                    |
|----|-----------------|---------------------|--|--------------------------|
| 1  | IS-A            | INTELLECTUAL ENTITY | YOSHIO TANAKA: GRADUATED KYUSHU UNIV.                                  | <input type="checkbox"/> |
| 2  | > NATIONARITY > | ---                 | TARO HITACHI: TOOK BACHELER OF ENGINEER AT UNIV. A                     | <input type="checkbox"/> |
| 3  | > BIRTH PLACE > | ---                 | KOZO YOSHIKAWA: DESIGNED KOPO - ARAKAWA                                | <input type="checkbox"/> |
| 4  | > AGE >         | ---                 | SUZUKI TRADE CO.: ASKED TARO HITACHI TO BUILD 14TH OCHANOMIZU BUILDING | <input type="checkbox"/> |
| 65 | < EMPLOYEE <    | ---                 |  | <input type="checkbox"/> |

38/72

|                      |  |              |                |
|----------------------|--|--------------|----------------|
| VIEW                 | FONT   |              |                |
| UNIVERSAL<br>CONCEPT | 3802   | [COMPANY]: ? |                |
| < TAKE >             | VIEW   | REGISTER     | CLOSE          |
| 1                    | TOOK DOCTORATE AT UNIV. B IN 1975.                 |              |                |
| 2                    | TARO HITACHI TOOK BACHELOR OF ENGINEERING IN 1970. |              |                |
| 3                    | YOSHIO TANAKA TOOK LICENSE OF ARCHITECT.           |              |                |
| 4                    | REIKO SAGAWA TOOK LICENSE OF FLOWER DESIGNER       |              |                |
| 5                    | TARO HITACHI                                       | VIEW         | REGISTER CLOSE |

|   |                 |                          |
|---|-----------------|--------------------------|
| 1 | IS-A            | PERSON                   |
| 2 | > NATIONALITY > | JAPAN                    |
| 3 | > BIRTHPLACE >  | KANAGAWA PREFECTURE      |
| 4 | < DESIGNER OF < | MR. KATAGIRI'S RESIDENCE |
| 5 | .....           | .....                    |

|    |   |                 |
|----|---|-----------------|
| 1  | TARO HITACHI  | UNIV. A IN 1970 |
| 4  | TARO HITACHI TOOK DOCTORATE AT UNIV. B IN 1975                        |                 |
| 6  | (SET TARO HITACHI, YOSHIO TANAKA) SETUP OFFICE IN KOBUCHIZAWA         |                 |
| 25 | SUZUKI TRADE CO. ASKED TARO HITACHI TO BUILD 14TH OCHANOMIZU BUILDING |                 |

UNIVERSAL

CONCEPT — ENTITY

SOCIETY

CHIZUKO TAKASHINA

PERSON — TARO HITACHI

HIGH SCHOOL

SEARCH CONCEPT

UNDER

CONCEPT

# FIG. 39

39/72

|  |  |  |  |
|--|--|--|--|
| VIEW   |  | FONT   |  |
| UNIVERSAL<br> <br>CONCEPT<br> <br>INTELLECTUAL ENTITY<br> <br>ORGANIZATION<br> <br>COMPANY |  | [COMPANY]:?<br><br>IT HAS [OFFICE] IN [SHINSHU].<br>IT WAS REBUILT BY [PERSON].<br>IT PUBLISHED [ESSAY] [MAGAZINE].<br>IT BOUGHT [ISLAND] IN [TIME]. |  |

|           |  |               |  |              |  |          |  |
|-----------|--|---------------|--|--------------|--|----------|--|
| RELATION  |  | BE-RELATION   |  | NATIONALITY  |  | TAKE     |  |
| 3902      |  | <NATIONALITY> |  | VIEW         |  | REGISTER |  |
| UNIVERSAL |  | 1             |  | TARO HITACHI |  | JAPAN    |  |
|           |  | 2             |  | REIKO SAGAWA |  | JAPAN    |  |
|           |  |               |  |              |  | 3903     |  |

|              |  |      |  |               |  |                             |  |
|--------------|--|------|--|---------------|--|-----------------------------|--|
| TARO HITACHI |  | VIEW |  | REGISTER      |  | CLOSE                       |  |
| 3904         |  | 1    |  | IS-A          |  | PERSON                      |  |
|              |  | 2    |  | >NATIONALITY> |  | JAPAN                       |  |
|              |  | 3    |  | >BIRTHPLACE>  |  | KANAGAWA<br>PREFECTURE      |  |
|              |  | 4    |  | <DESIGNER-OF< |  | Mr. KATAGIRI'S<br>RESIDENCE |  |
|              |  | 5    |  |               |  |                             |  |

|    |  |   |  |
|----|--|---|--|
| 1  |  | TARO HITACHI GRADUATED UNIV. A IN 1970                                |  |
| 4  |  | TARO HITACHI TOOK DOCTORATE AT UNIV. B IN 1975                        |  |
| 6  |  | (SET TARO HITACHI, YOSHIO TANAKA SETUP OFFICE IN KOBUCHIZAWA          |  |
| 25 |  | SUZUKI TRADE CO. ASKED TARO HITACHI TO BUILD 14TH OCHANOMIZU BUILDING |  |

# FIG. 40

VIEW

FONT

UNIVERSAL  
CONCEPT  
INTELLECTUAL ENTITY  
ORGANIZATION

4001

[COMPANY] : ?

IT HAS [OFFICE] IN [SHINSHU].

IT WAS REBUILT BY [PERSON].

IT PUBLISHED [ESSAY] [MAGAZINE].

< TARO HITACHI >

VIEW

RESISTER

CLOSE

PERSON

4002

1 IS-A

TARO HITACHI GRADUATED UNIV. A IN 1970

2 > NATIONALITY >

TARO HITACHI TOOK DOCTORATE AT UNIV. B IN 1975

3 > BIRTHPLACE >

(SET TARO HITACHI, YOSHIO TANAKA) SETUP OFFICE IN KOBUCHIZAWA

4 < DESIGNER-OF <

SUZUKI TRADE CO. ASKED TARO HITACHI TO BUILD 14TH OCHANOMIZU BUILDING

< JAPAN >

VIEW

RESISTER

CLOSE

NATION

4003

1 IS-A

ELIZABETH : VISITED JAPAN.

2 PART-OF

AZUMAZEKI-OYAKATA WAS NATURALIZED IN JAPAN.

3 > NATIONALITY >

TARO HITACHI

7 MEMBER NATION

DR. HAWKING MADE A SPEECH IN JAPAN 1991.

SEARCH CONCEPT

UNDER

CONCEPT

40/72



# FIG. 41

4101

4102

| < TARO HITACHI > |                 | VIEW                        | RESISTER                 | CLOSE   |
|------------------|-----------------|-----------------------------|--------------------------|---|
| 1                | IS-A            | PERSON                      | <input type="checkbox"/> | TARO HITACHI GRADUATED UNIV. A IN 1970  |
| 2                | > NATIONALITY > | JAPAN                       | <input type="checkbox"/> | TARO HITACHI TOOK DOCTORATE AT UNIV. B 1975   |
| 3                | > BIRTHPLACE >  | KANAGAWA<br>PREFECTURE      | <input type="checkbox"/> | <div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: 80%;">           TARO HITACHI : TOOK DOCTORATE<br/>AT UNIV. B IN 1975.         </div> |
| 4                | < DESIGNER-OF < | Mr. KATAGIRI'S<br>RESIDENCE | <input type="checkbox"/> |   |
| 5                | ---             | ---                         | <input type="checkbox"/> |   |

4103

## FIG. 42

4201 4231 4233 4215 4211

VIEW FONT

UNIVERSAL 4203  
CONCEPT

[COMPANY] : ? 4217

IT WAS ESTABLISHED BY [PERSON]. 4219

ITS PLACE IS [TOKYO]. 4219

INTELLECTUAL ENTITY

PERSON 4207  
4205

CONDIDATE SENTENCE [PERSON]

◇ IT PRESENTED [THING] TO [A UNIVERSITY].

◇ IT TOOK [LICENSE] AT [A UNIVERSITY].

◇ IT GRADUATED FROM [A UNIVERSITY]

FOCUSED CONCEPT A UNIVERSITY

PERSON 4225 4223

WORKING PERSON PHOTOGRAPHER

PEOPLE.

SEARCH CONCEPT 4241 UNDER

4227 INTELLECTUAL ENTITY 4229

4221

# FIG. 43

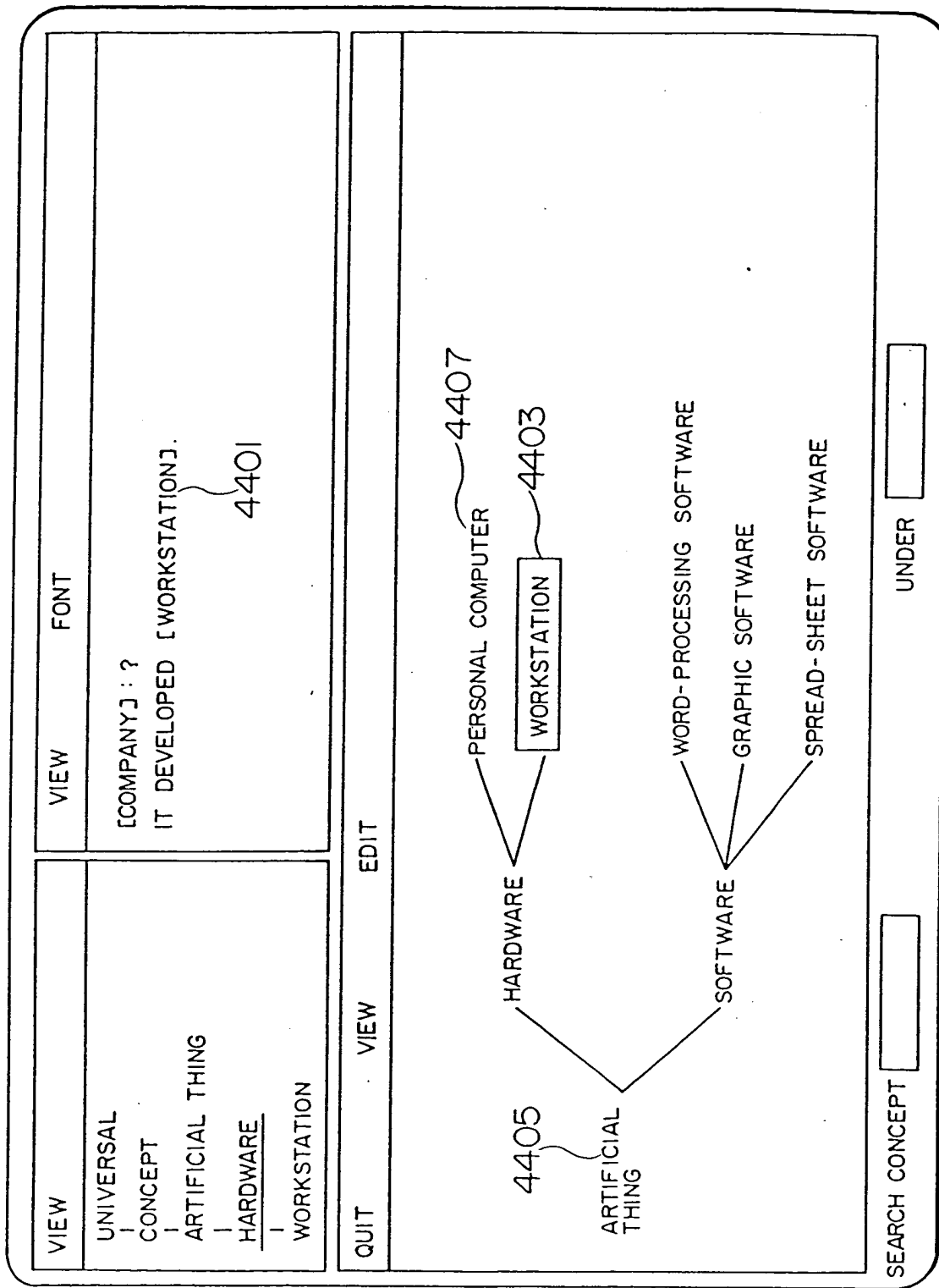
4303

|   |      |   |  |
|---|------|---|--|
| VIEW  |      | FONT  |  |
| UNIVERSAL<br> <br>CONCE<br> <br>INTELLECTUAL ENTITY<br> <br>PERSON 4305   |      | [COMPANY] : ?<br>IT WAS ESTABLISHED BY [PERSON].<br>IT GRADUATED FROM [A UNIVERSITY]. |  |
| QUIT  | VIEW | EDIT  |  |
| <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>4301</p> <p>PERSON</p> </div> <div style="text-align: center;"> <p>PHOTOGRAPHER</p> </div> <div style="text-align: center;"> <p>DESIGNER</p> </div> <div style="text-align: center;"> <p>OWNER</p> </div> <div style="text-align: center;"> <p>JAPANESE</p> </div> <div style="text-align: center;"> <p>AMERICAN</p> </div> <div style="text-align: center;"> <p>TARO HITACHI</p> </div> </div> |      |   |  |
| SEARCH CONCEPT  |      | UNDER   |  |

43/72

0 1 2 3 4 5 6 7 8 9

FIG. 44



44/72 8 11 1

FIG. 45

4501

4511

|                      |               |      |
|----------------------|---------------|------|
| VIEW                 | VIEW          | FONT |
| UNIVERSAL<br>CONCEPT | [CONCEPT] : ? |      |

4521

---

QUIT

4523

CONCEPT

THING — ARTIFICIAL THING — CONSTRUCTION — COMPANY

PLACE — ORGANIZATION — PERSON

INTELLECTUAL ENTITY

SEARCH CONCEPT

UNDER

45/72

010

FIG. 46

4601

VIEW

UNIVERSA

VIEW

FONT

[COMPANY] : ?

CLOSE

CANDIDATE SENTENCE [COMPANY]

◇ ITS INDUSTRY IS [INDUSTRY].

◇ ITS PLACE IS [PLACE].

◇ IT WAS ASKED TO DO [WORK] BY [INTELLECTUAL ENTITY]

4611

4613

4621

FOCUSED CONCEPT

4631

CONCEPT — INTELLECTUAL ENTITY

ORGANIZATION — COMPANY

PERSON — WORKING PERSON — PEOPLE

DESIGNER

PHOTOGRAPHER

CASE SELECTION

4641

4651

INITIALIZE

ADD

SEARCH CONCEPT

UNDER

46172

00

# FIG. 47

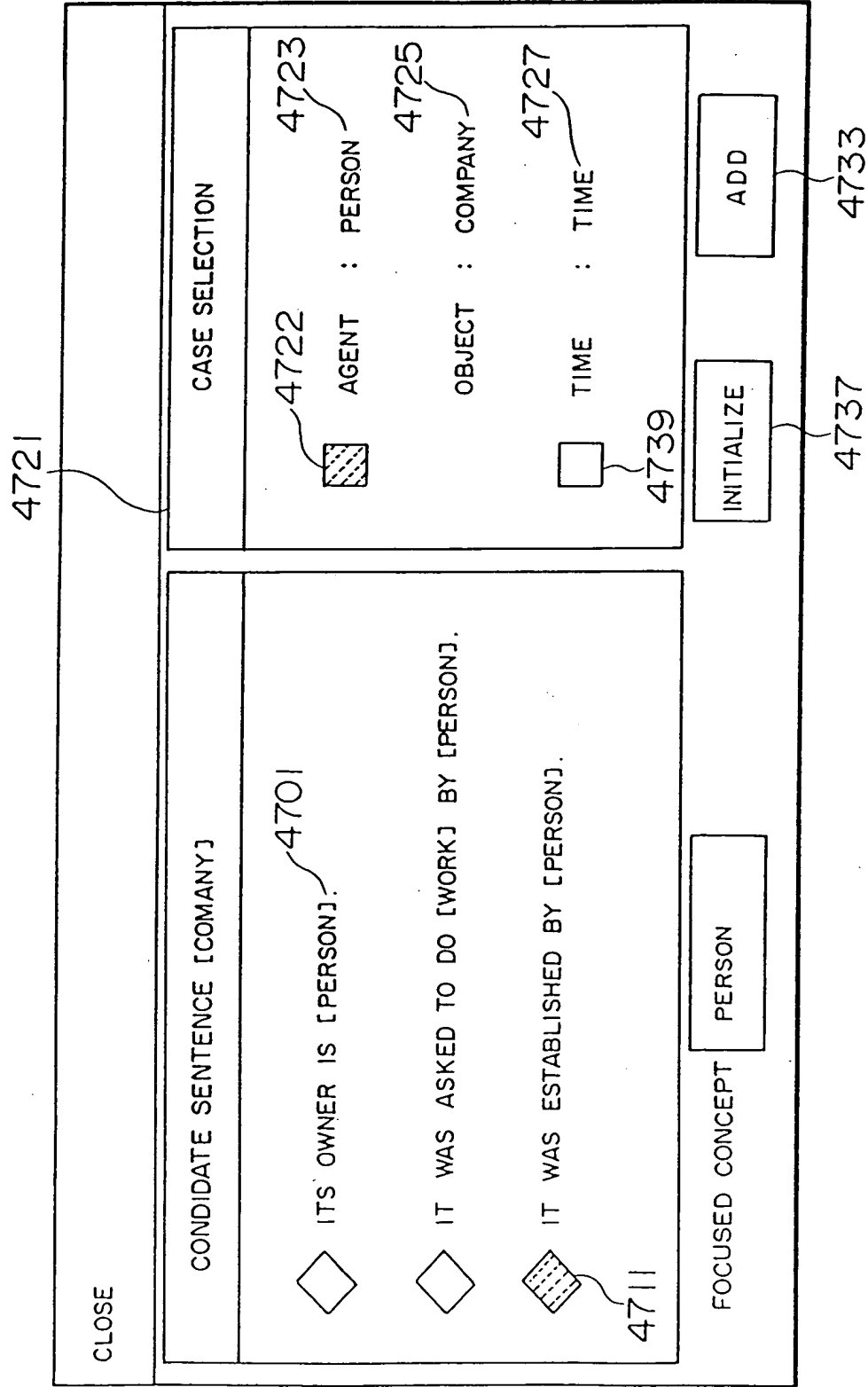



FIG. 48

|   |  |
|---|--|
| CLOSE   |  |
| <div>CANDIDATE SENTENCE [PERSON]<br/><br/>4801<br/> IT TOOK [DOCTORATE] AT [A UNIVERSITY].</div> | <div>CASE SELECTION<br/><br/>AGENT : PERSON<br/><br/>PLACE : TOHOKU UNIVERSITY<br/><br/>OBJECT : DOCTORATE<br/><br/><input type="checkbox"/> TIME : TIME</div> |
| <div>FOCUSED CONCEPT<br/><br/>DOCTORATE</div>   | <div>INITIALIZE<br/><br/>ADD</div>   |

4807



## FIG. 49

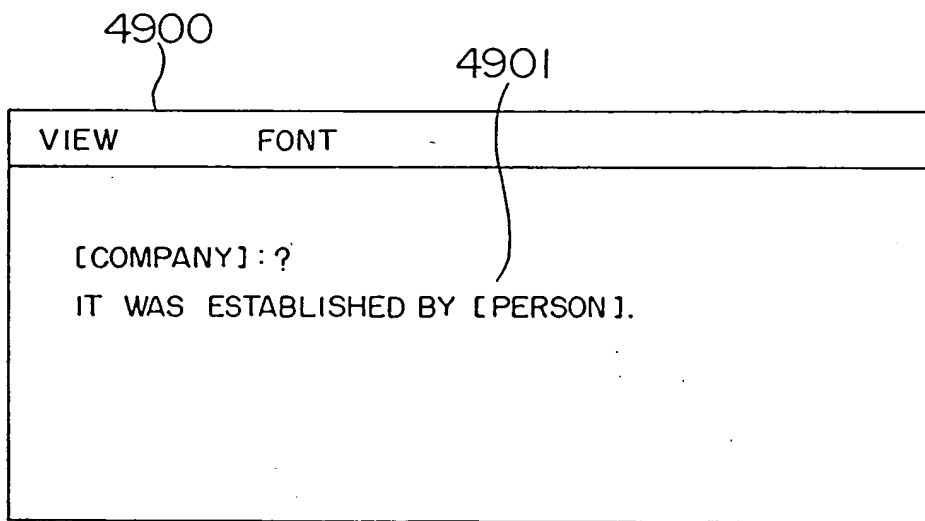


FIG. 50

5000 5010 5001

|   |   |       |  |
|---|---|-------|--|
| VIEW  |   | FONT  |  |
| UNIVERSAL<br> <br>CONCEPT<br> <br>ABSTRACT THING<br> <br><u>LICENCE</u>   | [COMPANY] : ? 5003 5004<br>IT WAS ESTABLISHED BY [PERSON].<br>IT TOOK [LICENSE] AT [A UNIVERSITY].<br>ITS PLACE IS [TOKYO]. 5005<br>5006 5007 |       |  |
| QUIT  | VIEW  | EDIT  |  |
| <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">           5021<br/> <div style="border: 1px solid black; padding: 2px;">LICENSE</div> </div> <div style="text-align: center;">           DOCTORATE 5023<br/>           MASTER'S DEGREE<br/>           LICENSE OF ARCHITECT<br/>           AUTO-DRIVING LICENSE         </div> </div> |   |       |  |
| SEARCH CONCEPT  |   | UNDER |  |

5020

FIG. 51

5100

| VIEW   | FONT      |
|--|-----------|
| <p>[COMPANY] : ?</p> <p>IT WAS ESTABLISHED BY (SET : [F COMPANY] ; [H COMPANY] ).</p> <p>THE H COMPANY HAS [LABORATORY] IN (AND : [TOKYO] ; [UNITED STATES] ).</p> <p>THE ESTABLISHMENT OF THE H COMPANY IS (OR : [1900] ; [1910] ).</p> |           |
|  | 5101      |
|  | 5105      |
|  | 5102 5103 |

51/72

51

FIG. 52

| RESULT | 3 CASES                             | VIEW      | SELECTION | CLOSE |
|--------|-------------------------------------|-----------|-----------|-------|
| 5205   | <input checked="" type="checkbox"/> | TANAKA X  |           |       |
| 5206   | <input checked="" type="checkbox"/> | HITACHI Y |           |       |
| 5207   | <input type="checkbox"/>            | YAMADA Z  |           |       |

FIG. 53

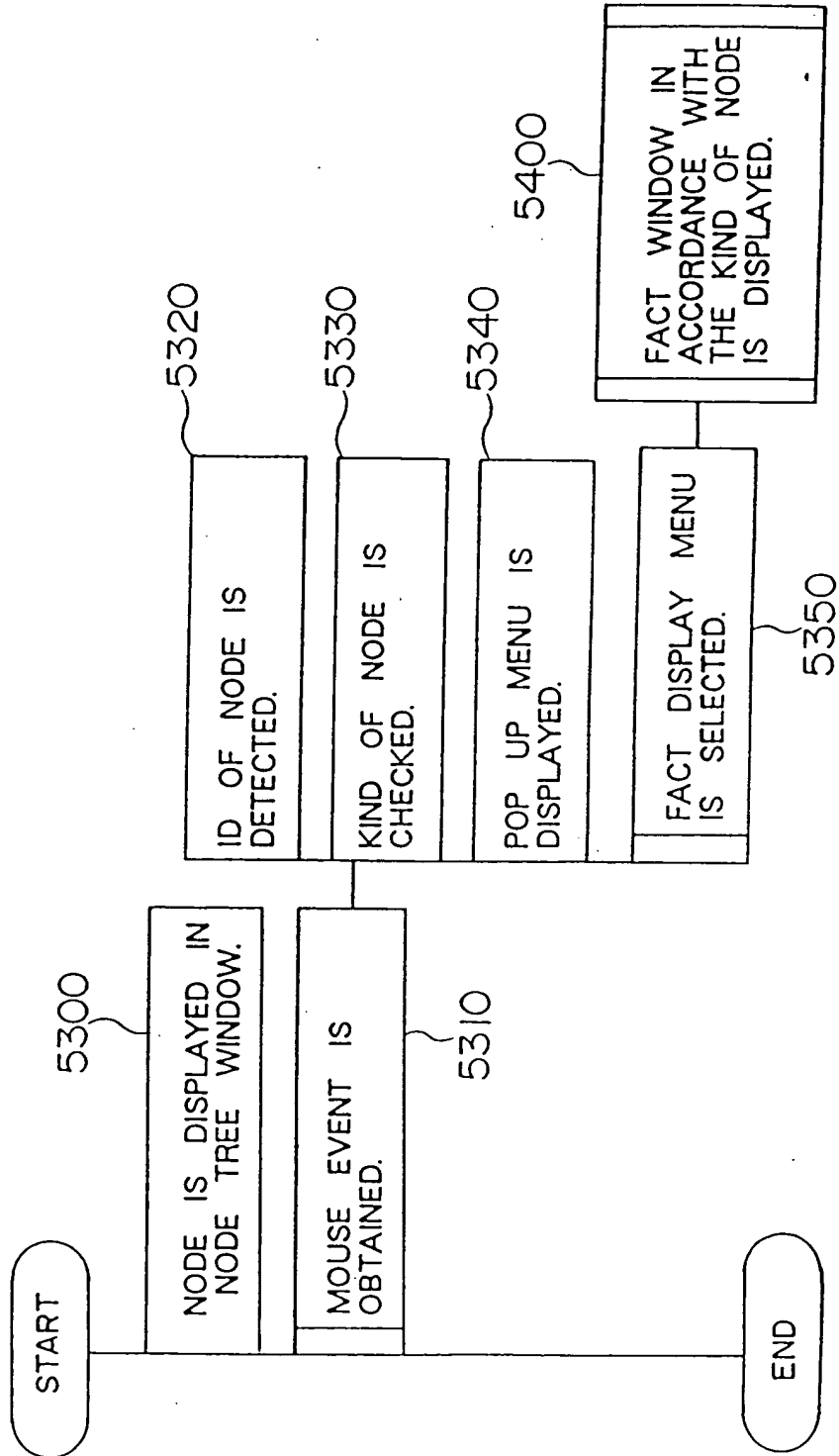
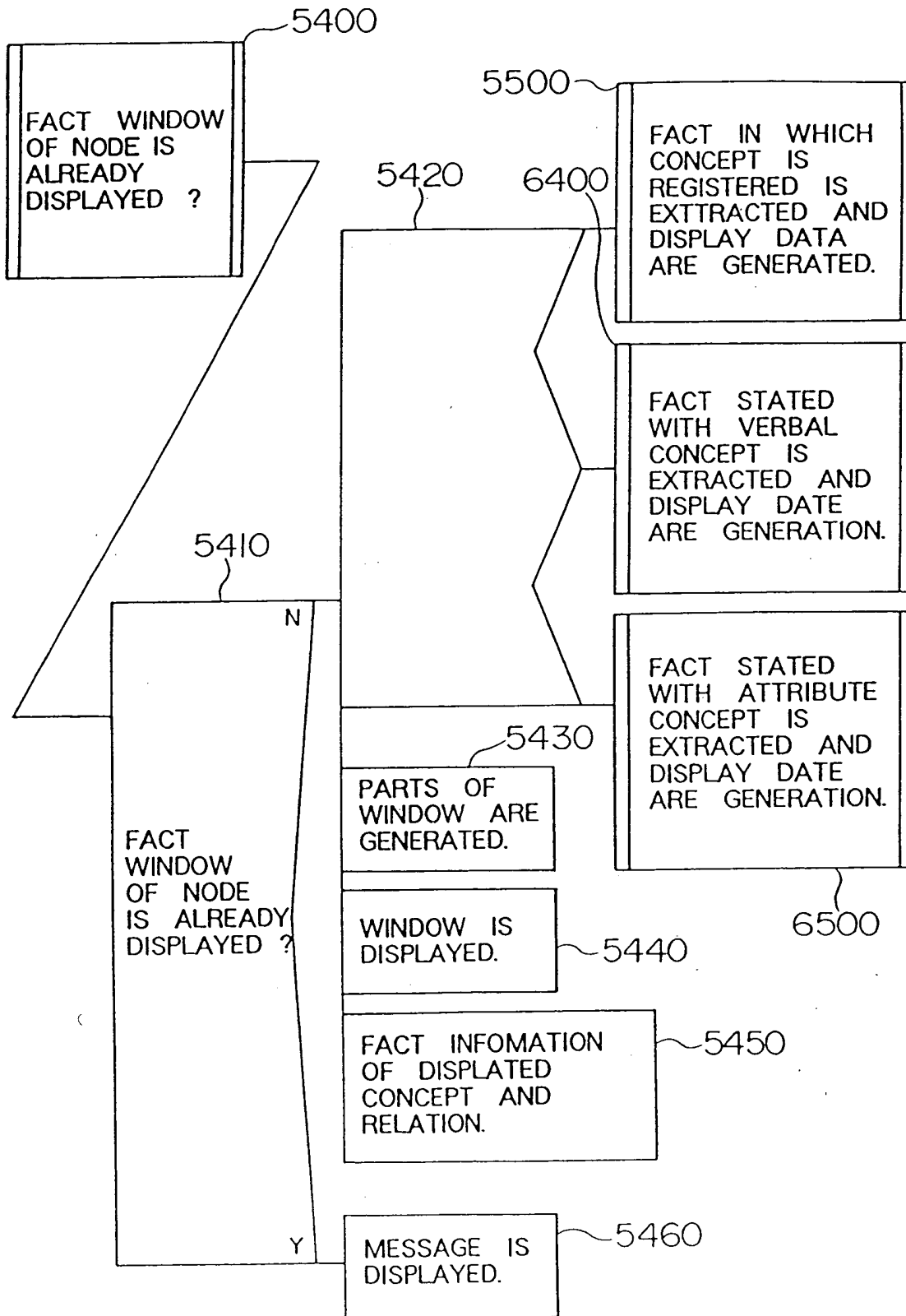


FIG. 54



```

graph TD
    5510[FACT ID LIST AND TOTAL NUMBER OF VERBLE FACTA TO BE DISPLAYED ARE INITIALIZED.] --> 5515[FACT ID LIST AND TOTAL NUMBER OF ATTRIBUTE FACTA TO BE DISPLAYED ARE INITIALIZED.]
    5515 --> 5520[POINTRER OF PRIORITY LIST OF VERBAL CONCEPT CASE IS NULL]
    5520 --> 5525{THERE EXIST VERBAL FACT STATED WITH SET OF CONCEPT AND CASE ?}
    5525 -- Y --> 5530[VERBAL FACT ID EXTACTED.]
    5525 -- N --> 5700[FACTS ARE GROUPED WITH RELATIONAL CONCEPT AND FACT INFORMATION TO BE DISPLAYED IS SELECTED.]
    5530 --> 5540[POINTER OF PRIORITY LIST OF VERBAL CONCEPT CASE IS NULL]
    5540 --> 5545{SUPER CONCEPT OF IS-A RERATION IS EXTRACTED.}
    5545 --> 5550[THERE EXISTS SUPER CONCEPT OF PART-WHOLE RELATION.]
    5550 --> 5555[POINT OF PRIORITY LIST OF ATTRIBUTE CONCEPT CASE IS NULL]
    5555 --> 5560{THERE EXISTS VERBAL FACT STATED WITH SET OF CONCEPT AND CASE ?}
    5560 -- Y --> 5570[ATTRIBUTE FACT IS EXTRACTED]
    5560 -- N --> 5700
    5570 --> 5700
    5700 --> 5900[DISPLAY DATA OF VERBAL FACT ARE GENERATED.]
    5900 --> 6200[DISPLAY DATA OF IS-A RELATION, PART-WHOLE RELATION, AND ATTRIBUTE FACT ARE GENERATED.]
  
```

FIG. 55

5510 FACT ID LIST AND TOTAL NUMBER OF VERBLE FACTA TO BE DISPLAYED ARE INITIALIZED.

5515 FACT ID LIST AND TOTAL NUMBER OF ATTRIBUTE FACTA TO BE DISPLAYED ARE INITIALIZED.

5520 POINTRER OF PRIORITY LIST OF VERBAL CONCEPT CASE IS NULL

5525 THERE EXIST VERBAL FACT STATED WITH SET OF CONCEPT AND CASE ?

5530 VERBAL FACT ID EXTACTED.

5700 FACTS ARE GROUPED WITH RELATIONAL CONCEPT AND FACT INFORMATION TO BE DISPLAYED IS SELECTED.

5540 POINTER OF PRIORITY LIST OF VERBAL CONCEPT CASE IS NULL

5545 SUPER CONCEPT OF IS-A RERATION IS EXTRACTED.

5550 THERE EXISTS SUPER CONCEPT OF PART-WHOLE RELATION.

5555 POINT OF PRIORITY LIST OF ATTRIBUTE CONCEPT CASE IS NULL

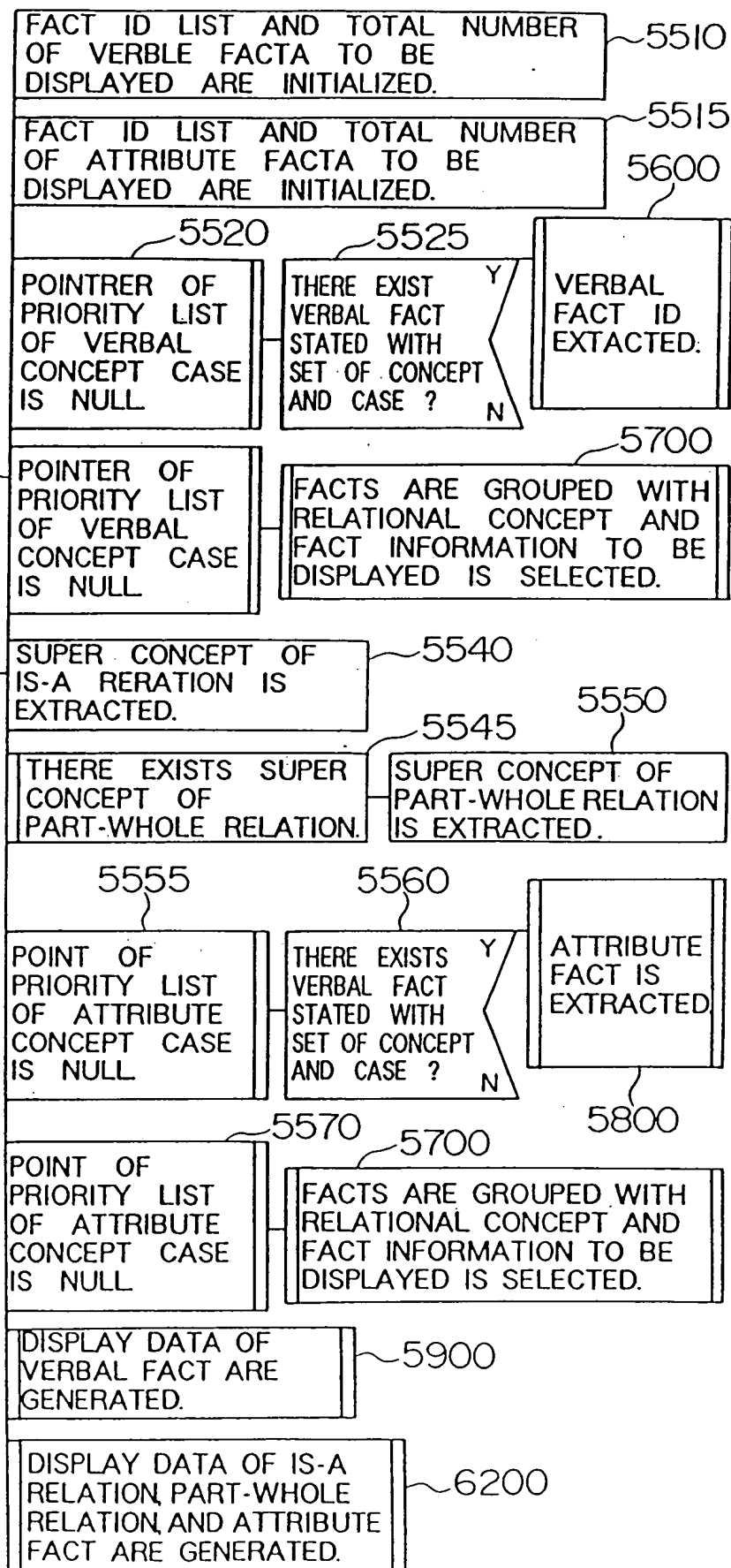
5560 THERE EXISTS VERBAL FACT STATED WITH SET OF CONCEPT AND CASE ?

5570 ATTRIBUTE FACT IS EXTRACTED

5700 FACTS ARE GROUPED WITH RELATIONAL CONCEPT AND FACT INFORMATION TO BE DISPLAYED IS SELECTED.

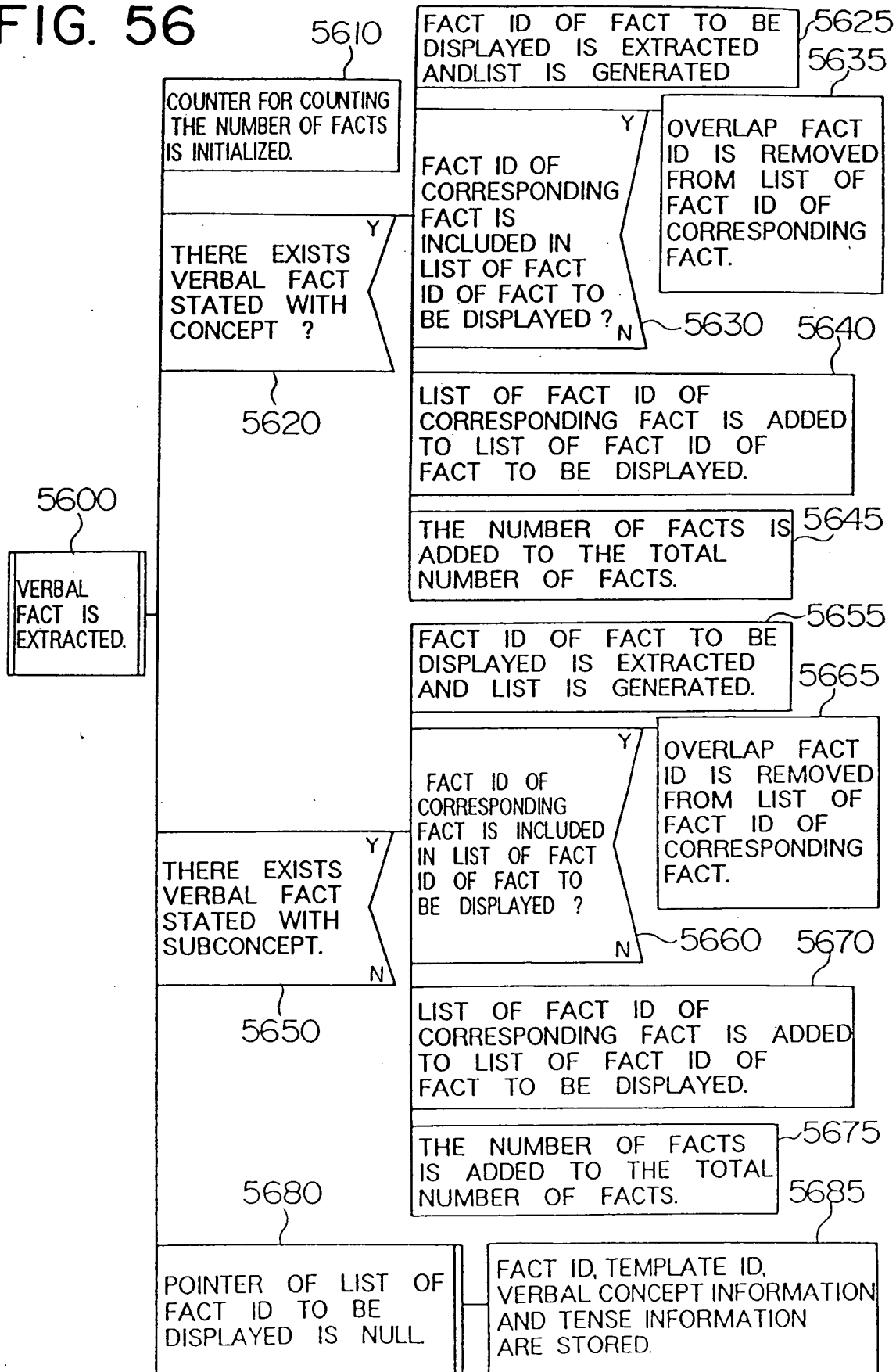
5900 DISPLAY DATA OF VERBAL FACT ARE GENERATED.

6200 DISPLAY DATA OF IS-A RELATION, PART-WHOLE RELATION, AND ATTRIBUTE FACT ARE GENERATED.



56/72

FIG. 56





5700

FACTS ARE GROUPED  
WITH RELATIONAL  
CONCEPT INFORMATION  
TO BE DISPLAYED IS  
SELECTED.

5710

POINTER OF LIST OF  
VIEW OF TABLE FOR  
FACT IS NULL

5720

THERE  
EXISTS CASE  
ORDER  
TABLE OF  
RELATIONAL  
CONCEPT ?

Y N

5725

THE TOTAL  
NUMBER OF FACTS  
> THRESHOLD ?

Y N

5740

CASE ORDER TABLE,  
AND VIEW TABLE FOR  
FACT ARE NEWLY  
GENERATED.

DISPLAY/NON-DISPLAY  
FLAG IS MADE TO BE  
'DISPLAY'.

5745

5760

5765

CASE ORDER TABLE,  
AND VIEW TABLE FOR  
FACT ARE NEWLY  
GENERATED.

DISPLAY/NON-DISPLAY  
FLAG IS MADE TO BE  
'DISPLAY'.

5770

THE NUMBER OF  
FACTS IN GROUP  
ARE ADDED.

5780

NUMBER IN FACT WINDOW  
IS GIVEN.

57/72

57/72

FIG. 57

FIG. 58

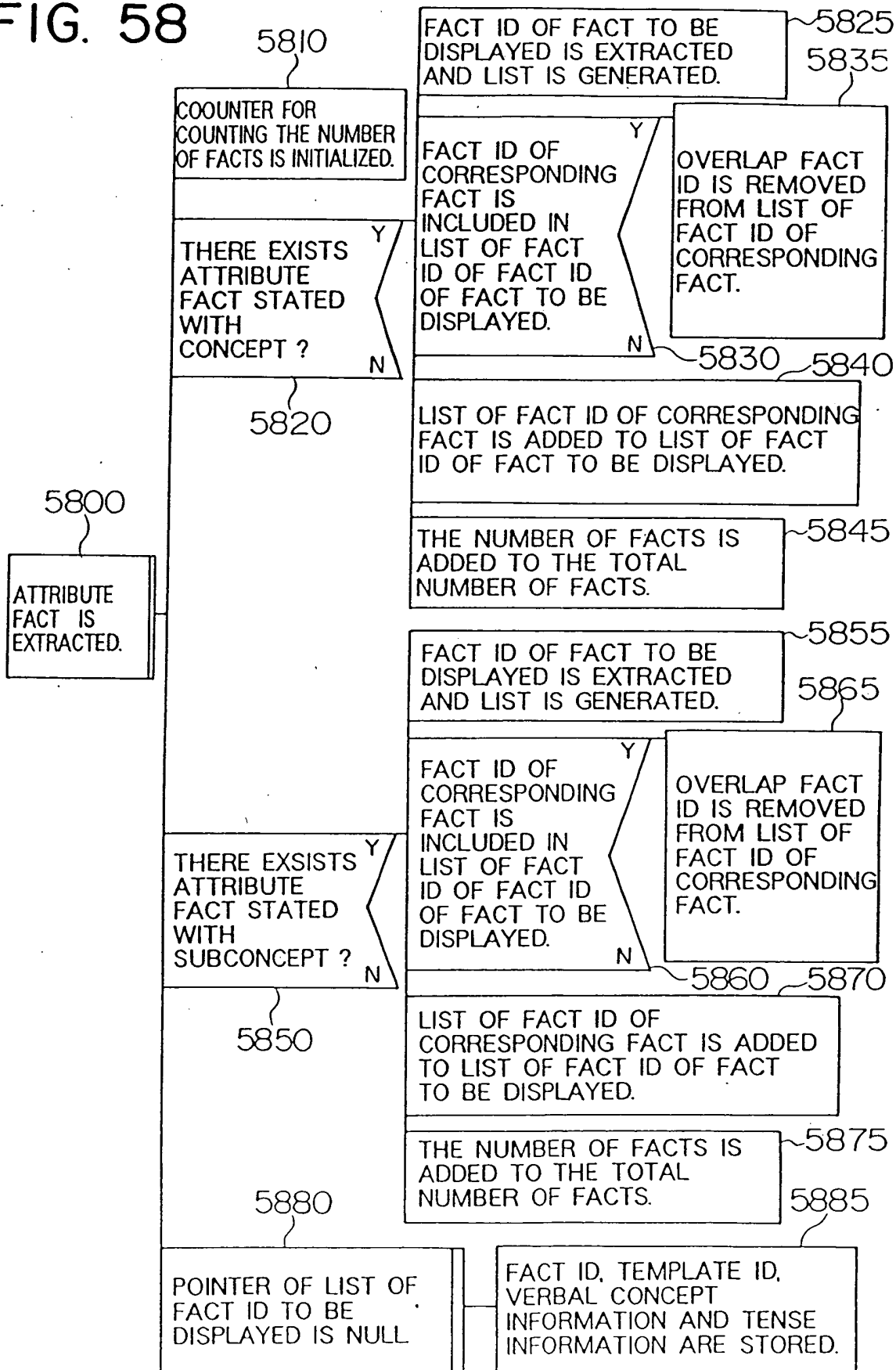
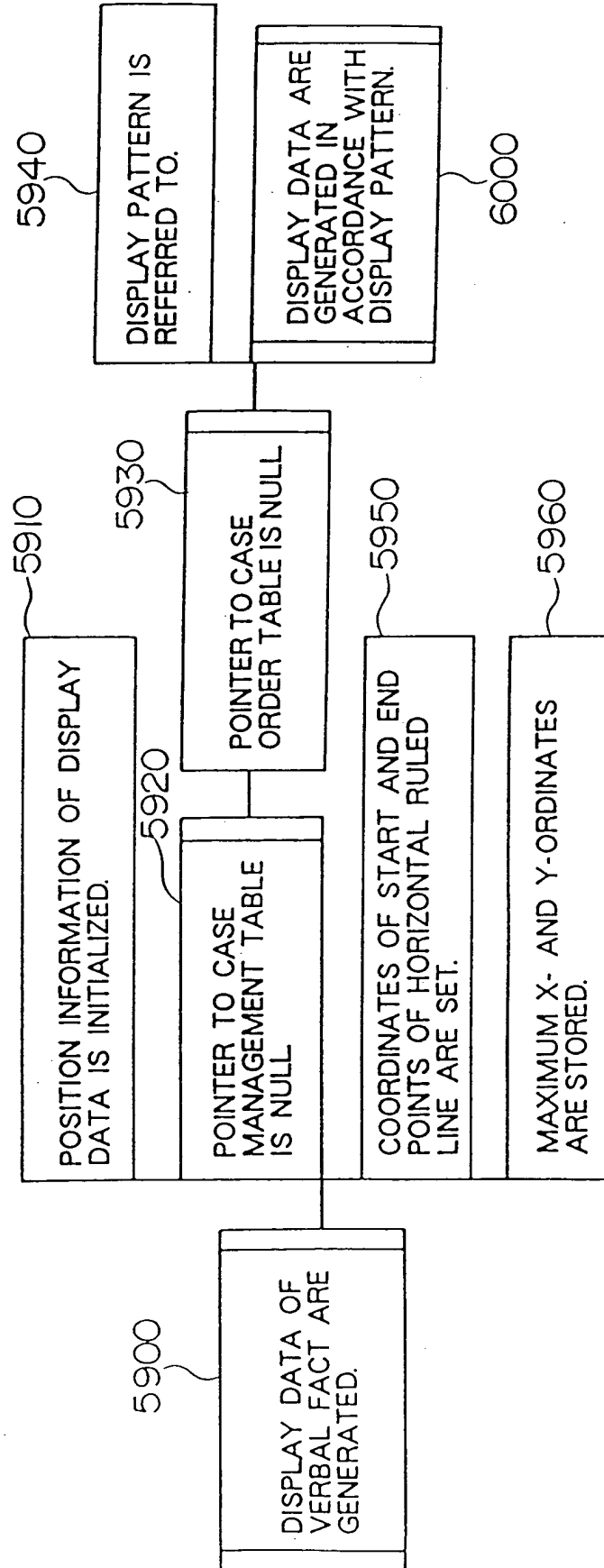


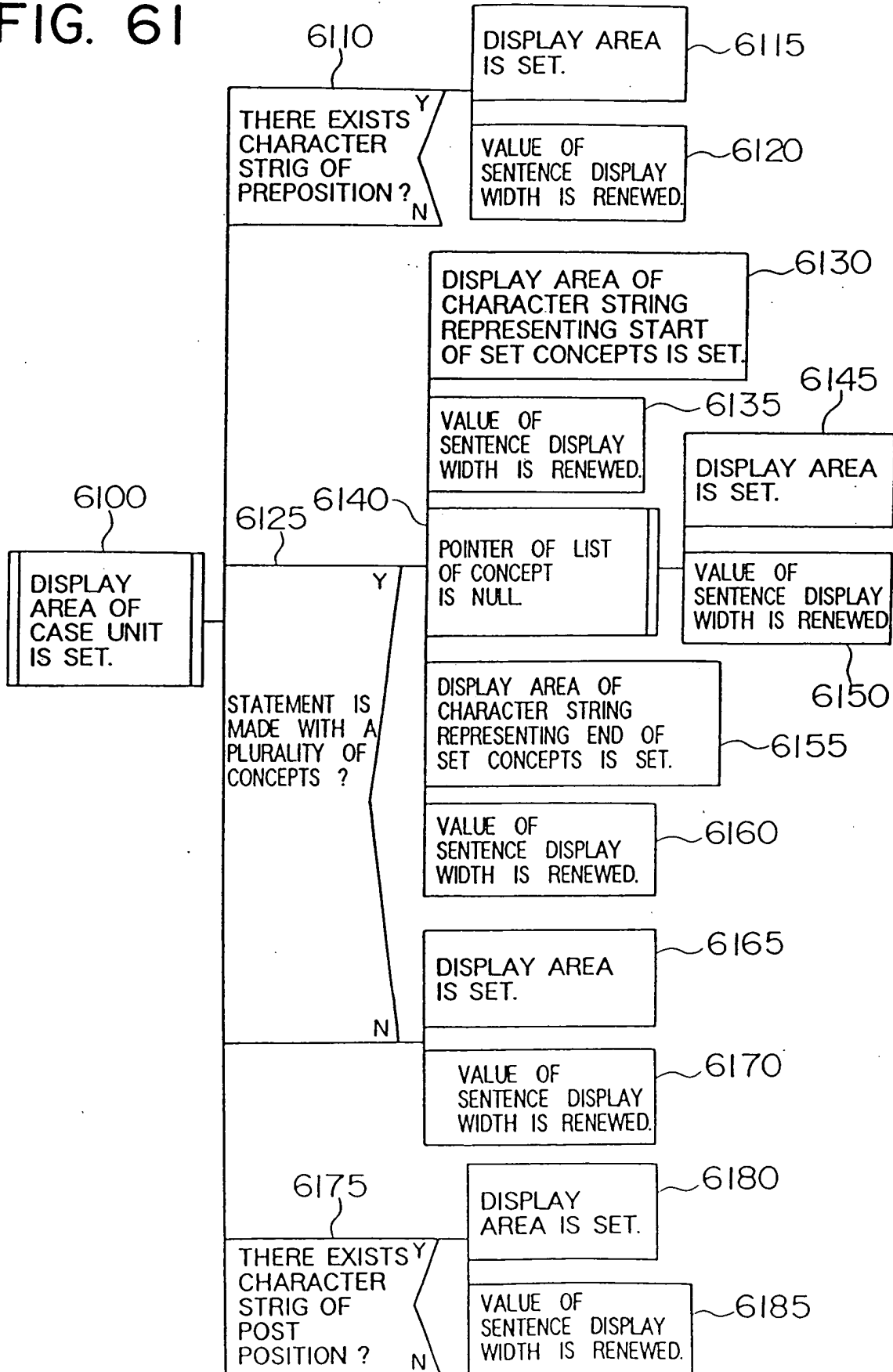
FIG. 59



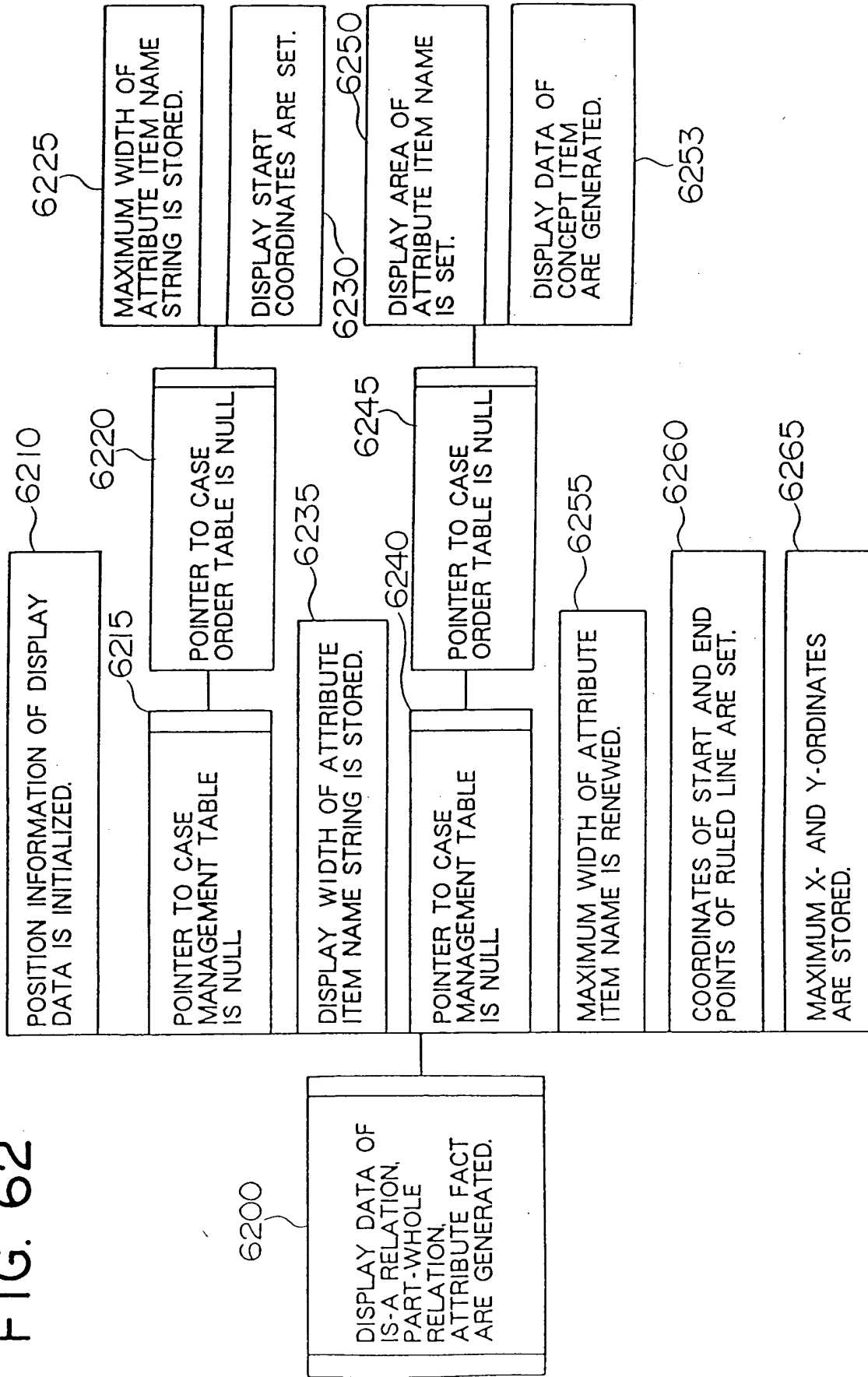


61/72

FIG. 61

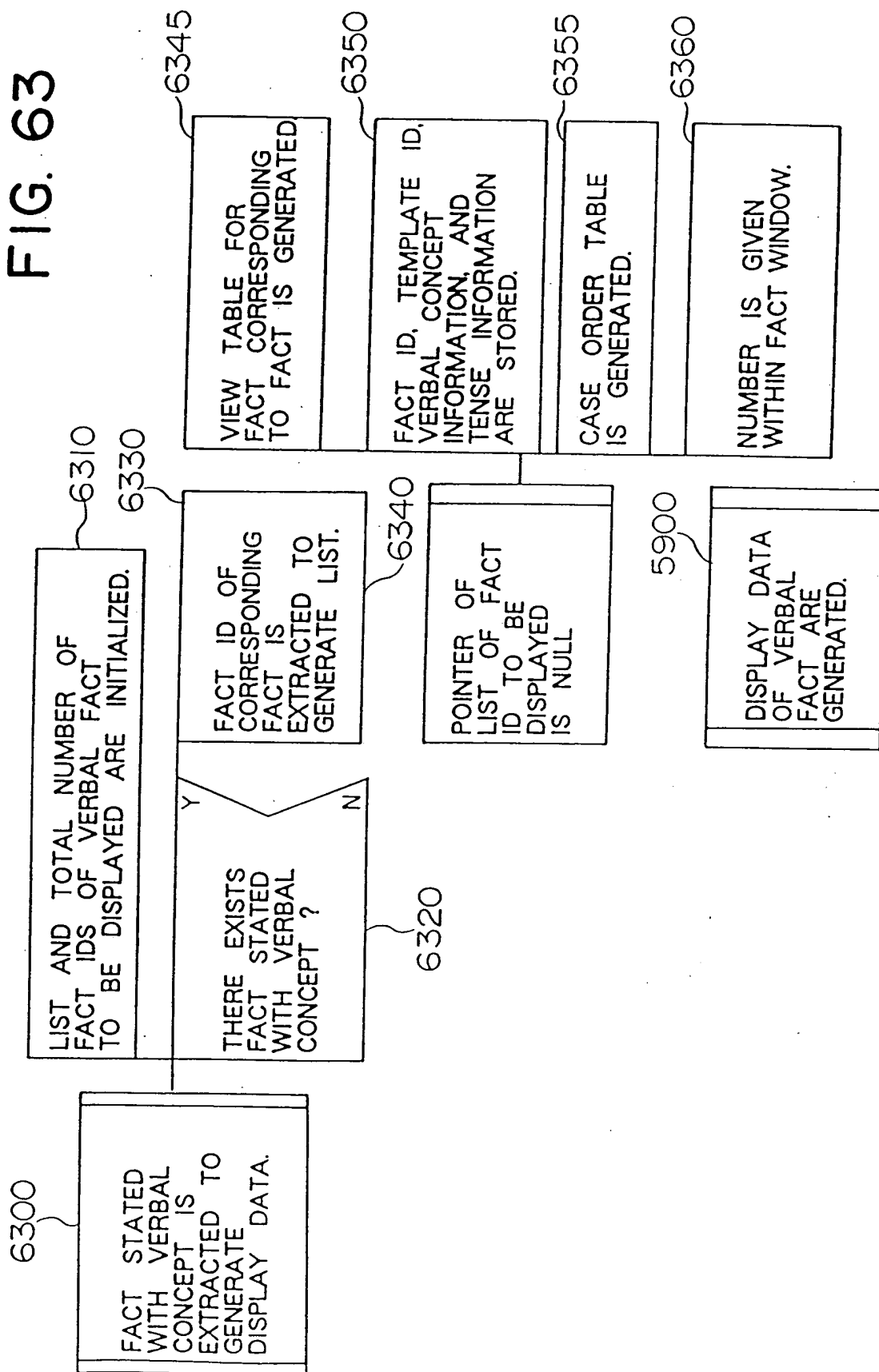


# FIG. 62



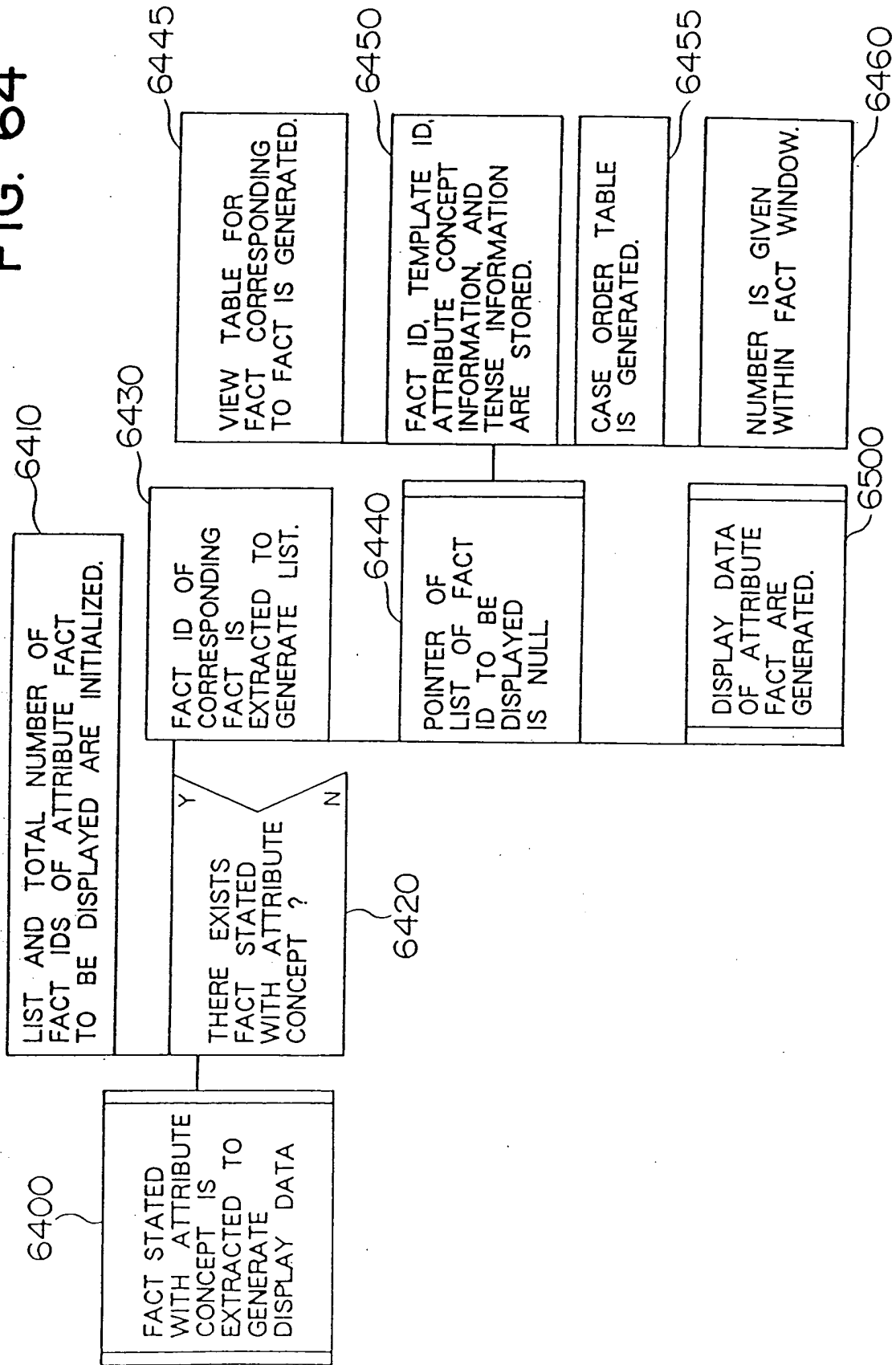
62/72

# FIG. 63



64/72

FIG. 64







66/72

66 72

FIG. 66

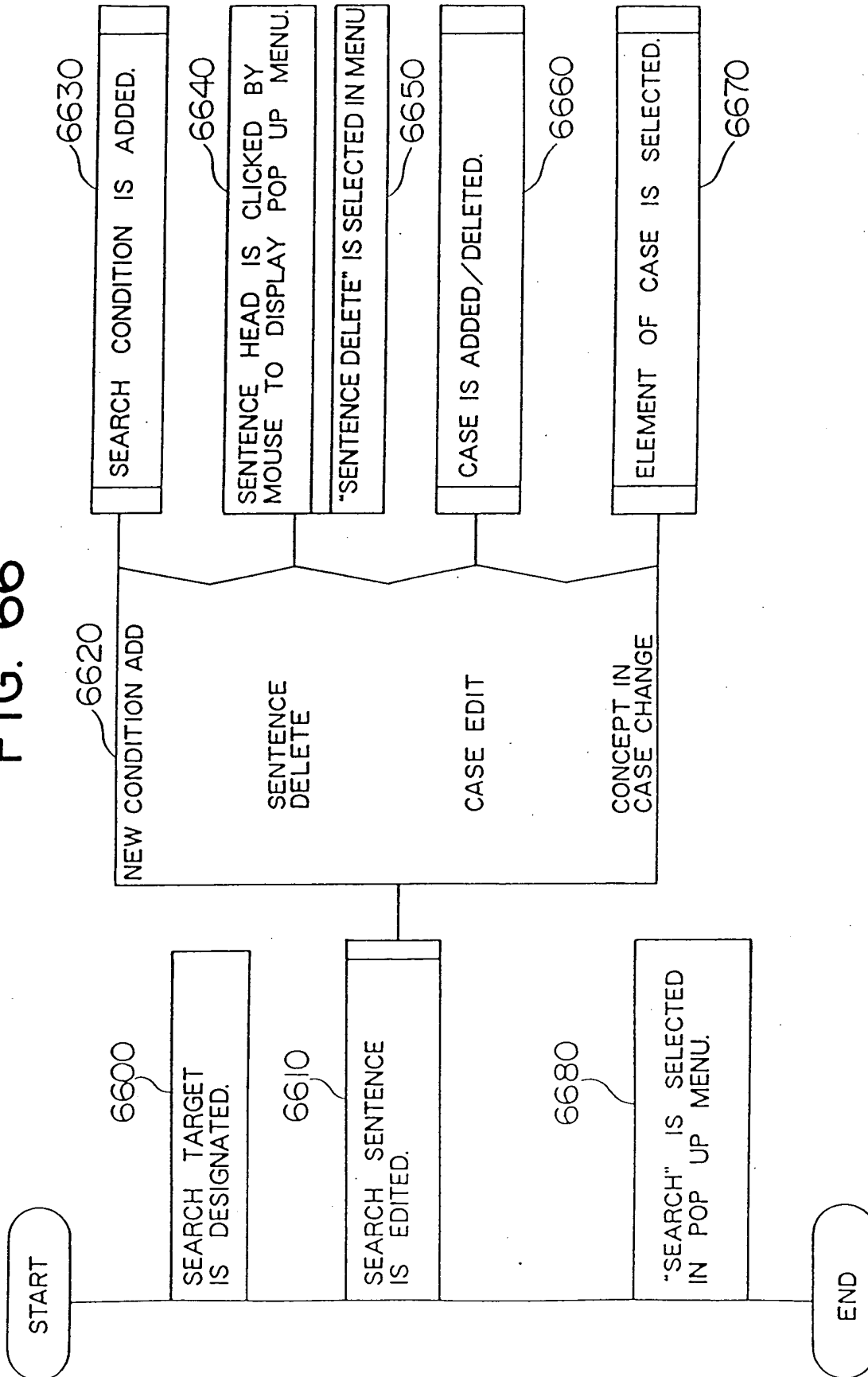
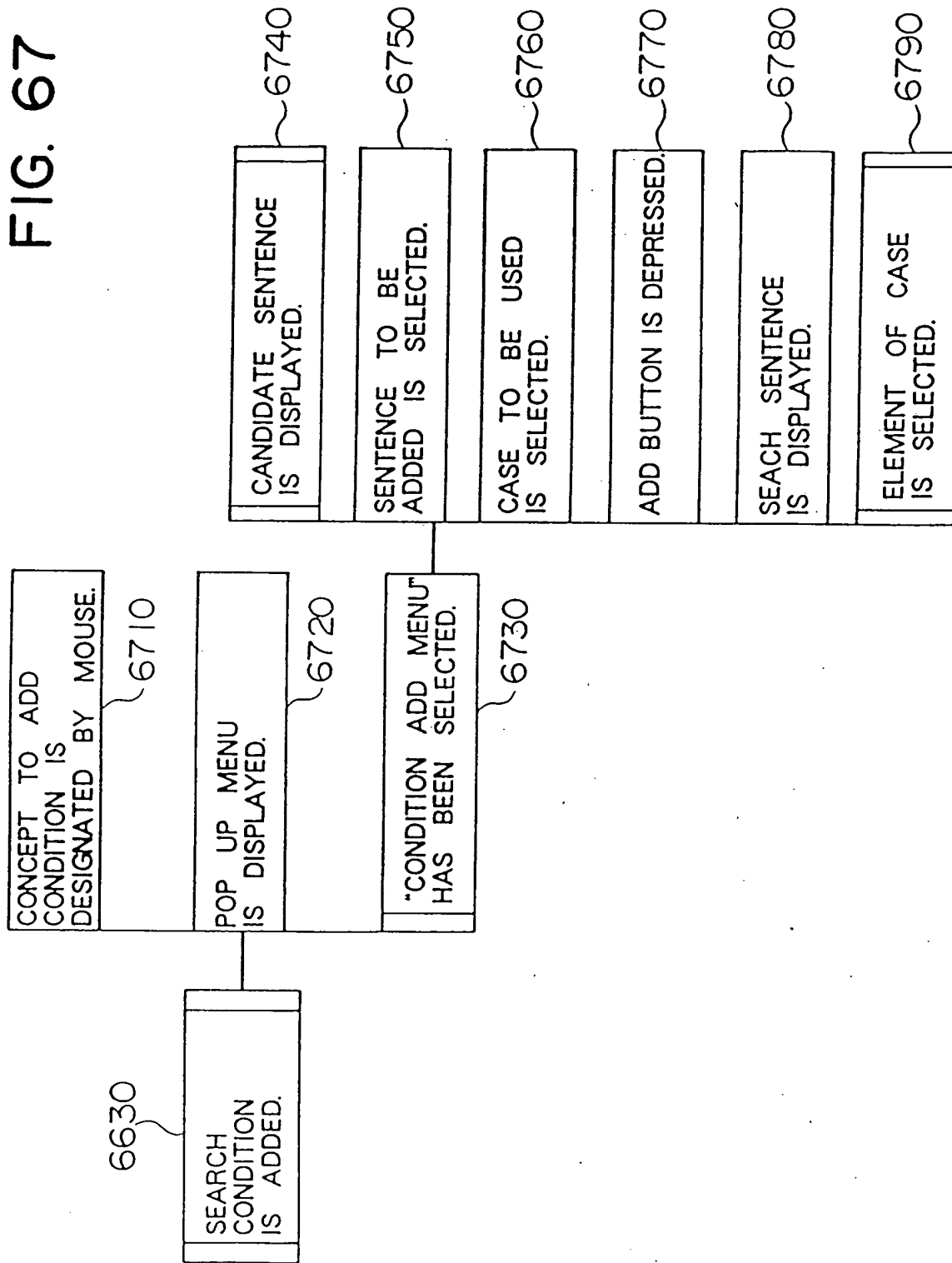


FIG. 67



67/72

(

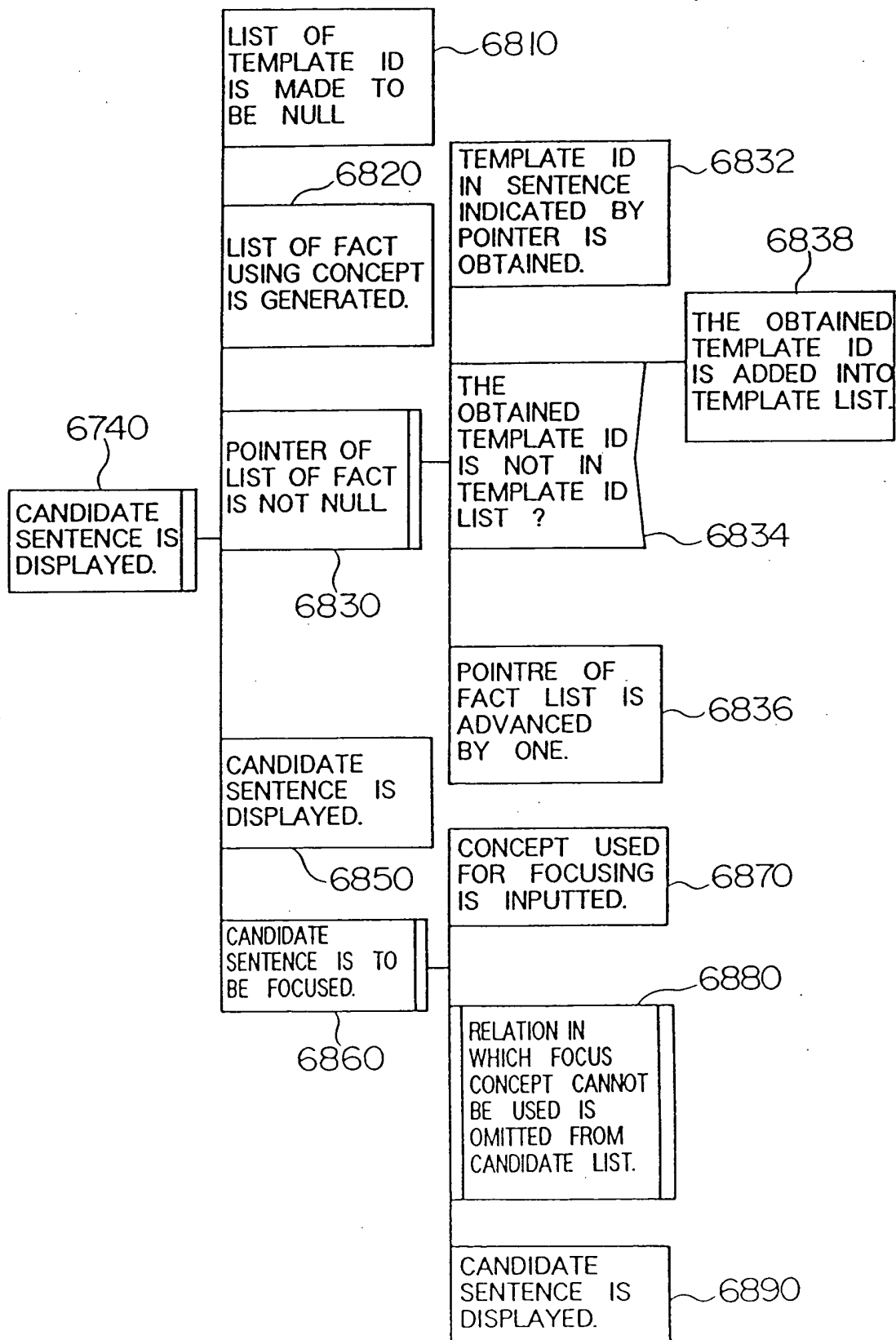


FIG. 69

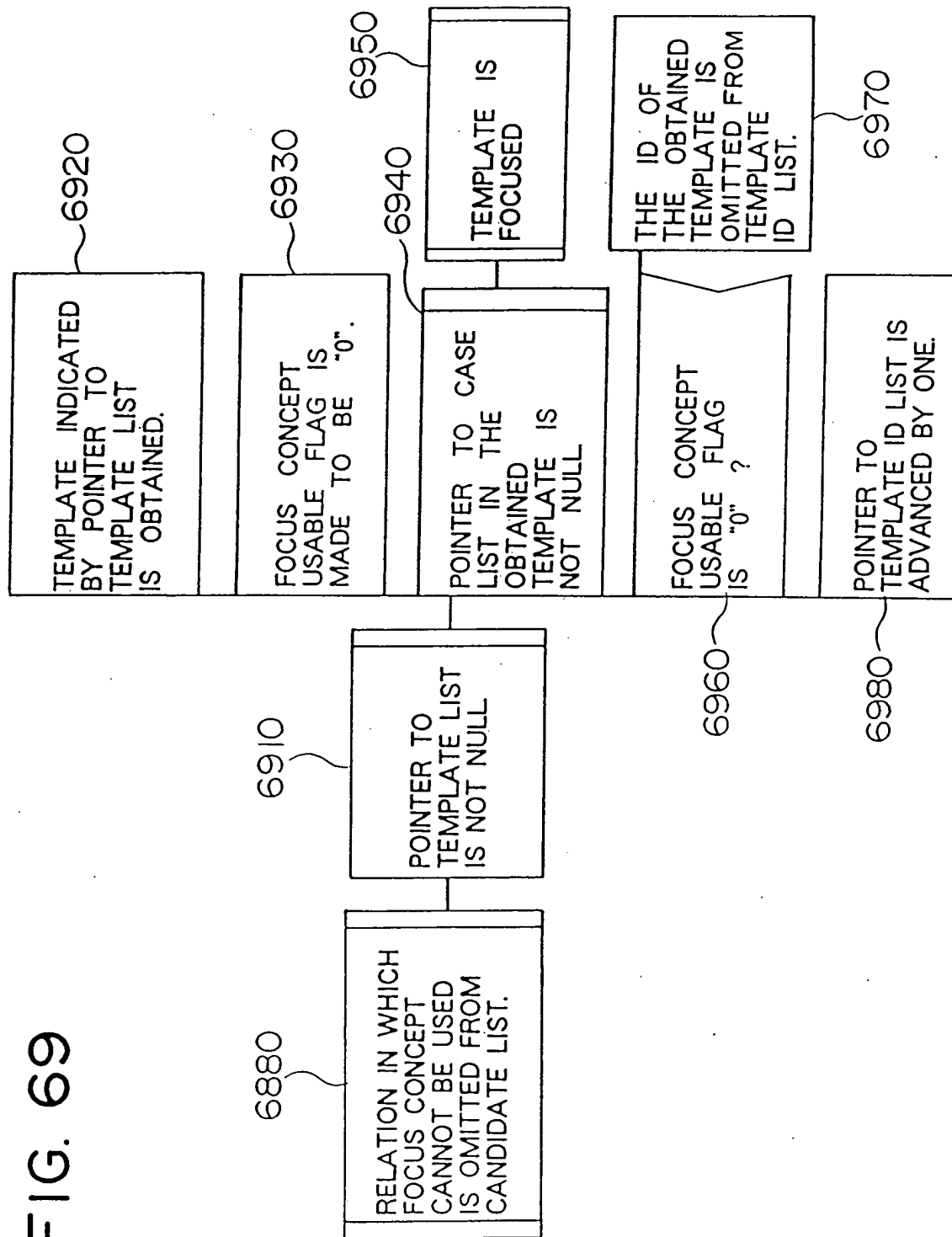


FIG. 70

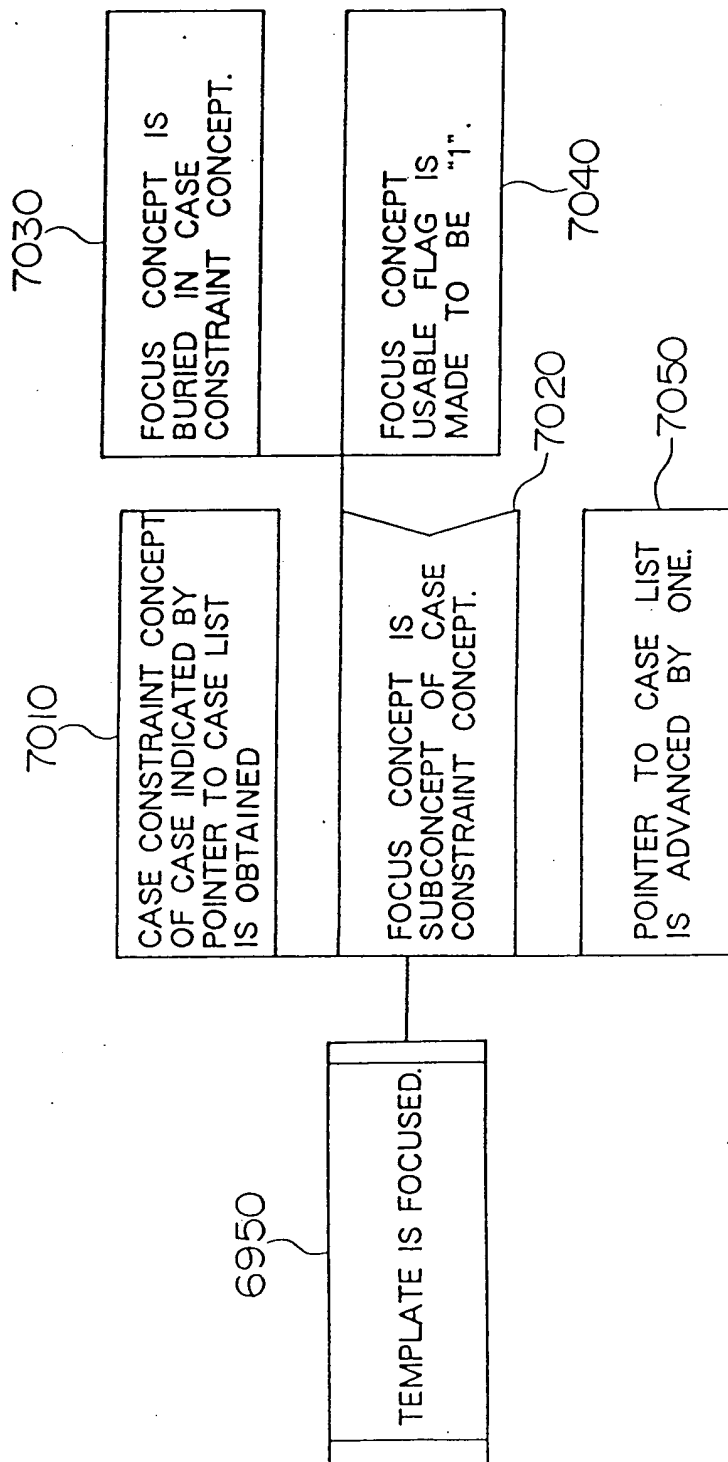


FIG. 71

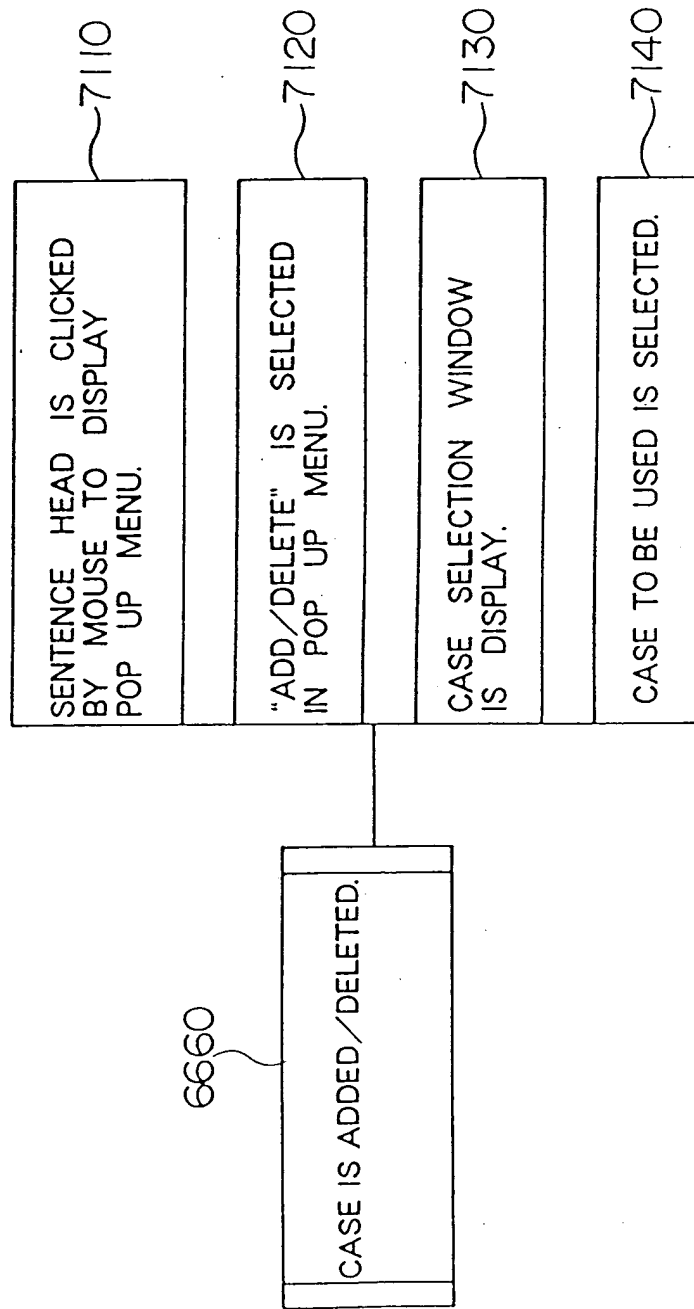
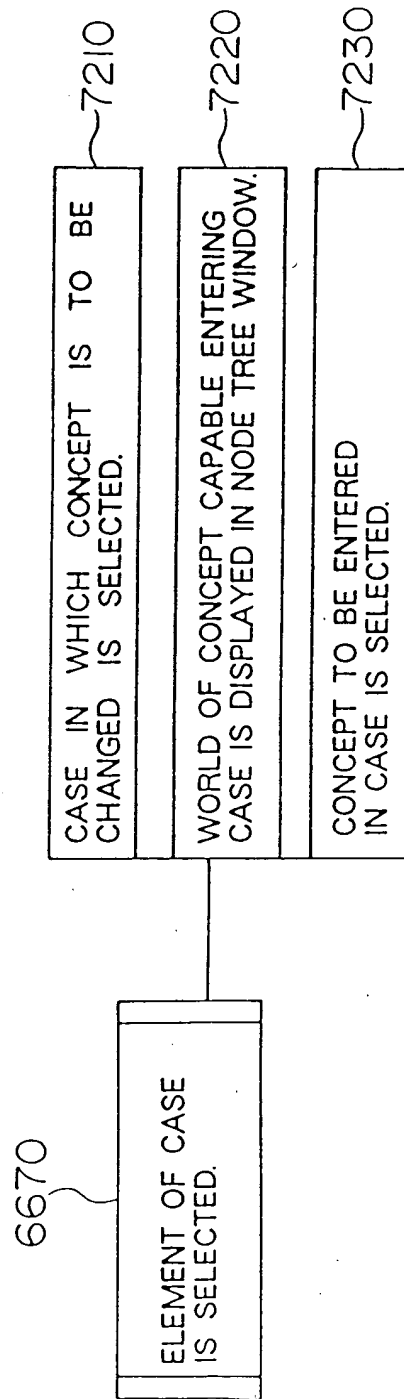


FIG. 72





INFORMATION STORAGE AND RETRIEVAL SYSTEM  
AND DISPLAY METHOD THEREFOR

1

The present invention relates to an information storage and retrieval system using a knowledge base and, particularly, relates to a display method in an information storage and retrieval system which permits inputting of semantic information such as a natural language in the form of knowledge to be processed by a computer, and freely displaying of the contents of a knowledge base stored in a computer system by using a multi-window function.

Heretofore, management of a data base which permits storage and retrieval of an enormous amount of information has been relied on by those skilled in the art. However, in accompaniment to the development of document filing systems using optical disks in recent years, such expert management is imposed on end users. For example, a command type inputting method which can be used easily by those skilled in the art is a large burden to the end users.

In conventional computer techniques, it is general that documents are managed in tubular form listing bibliographic data such as author's names and original sources attached to the documents when the documents are stored in this type document filing system. Because the bibliographic data are objective items, registration

1   thereof can be made easily. It is, however, relatively  
rare to use the bibliographic data as means for retrieval.  
al. In most cases, keywords and classification codes  
provided as clues to the contents of documents are used  
5   as means for retrieval. However, the following two  
problems arise in use of keywords. The first problem is  
encountered in registration of a document, in which it is  
difficult to determine the keyword which makes it possible  
to retrieve properly the associated document later  
10   on. The second problem is encountered in retrieval of a  
document, in which it is difficult to recall keywords to  
generate the retrieval formula composed of the keywords.

As an attempt to cope with the above problems,  
a research for data inputting by using a natural language  
15   has been proposed but has not been used widely. Because  
the interface for data inputting by using a natural  
language is not yet completed so that the percentage of  
correct analysis of input sentences is insufficient,  
there frequently arises the situation in which the system  
20   cannot analyze the input sentences so that the input  
sentences may be rejected or retrial may be requested.  
Knowledge of a large number of restrictions and rules is  
required for inputting sentences which can be analyzed  
correctly by the system. The labor required for  
25   remembering the restrictions and rules is equal to the  
labor required for remembering commands.

Accordingly, the present situation is that the  
document as an object of desire cannot be retrieved

1 speedily.

As an attempt to cope with the above problems,  
there is known a system in which a knowledge base is  
applied to the filing system, as disclosed in U.S. Patent  
5 4,868,733. Furthermore, some methods about display  
techniques in a knowledge base have been proposed.  
Furthermore, a method of exhibiting candidate sentences  
allowed to be inputted at the time of inputting of a  
sentence by using a knowledge base to thereby make it  
10 possible to select a sentence from the candidate  
sentences on the basis of user's judgment to reconcile  
both easy usability and easy analysis has been proposed  
as a sentence inputting method as disclosed in JP-A-1-  
140,332 (corresponding to U.S. application serial number  
15 07/27,684 filed, Nov. 25, 1988).

The expression of knowledge in a knowledge base  
as described in U.S. Patent 4,868,733 and JP-A-1-140,332  
will be described below with reference to Fig. 5.

Fig. 5 diagrammatically shows "concepts" stored  
20 in a knowledge base. In the drawing, the ellipses repre-  
sent "concepts", and the arrows represent "relations".  
In the knowledge base, concepts are hierarchically  
connected by is-a relations and part-whole relations.  
First, all concepts in the knowledge base are connected  
25 to one another by is-a relations under "UNIVERSAL" 501  
which is an uppermost concept defined to subsume all the  
other concepts. The is-a relation means the relation  
"concept X is (a) concept Y". By reference to a concept,

1 upper concepts than the concept are called super concepts  
and lower concepts than the concept are called subcon-  
cepts. For example, super concepts of "person" 515 are  
"intellectual entity" 505, "thing" 503 and "UNIVERSAL"  
5 501. Furthermore, some concepts are connected by part-  
whole relations. The part-whole relation means the  
relation "concept X is a part of concept Y". For  
example, "Shinshu" 529 is a part of "Japan" 527.  
Furthermore, each concept can have a plurality of is-a  
10 relations and part-whole relations. For example, super  
concepts of "company" 534 are two concepts "organization"  
507 and "place" 525.

In the knowledge base, a fact is expressed by  
two concepts and one relation, that is, by a binomial  
15 relation. First, two general concepts are linked by a  
general relation. Because the relation between two  
concepts is expressed in terms, the relation has two  
different relational names so that either of the concepts  
connected to both ends of the relation can be used as a  
20 subject. For example, concepts "person" 515 and "degree"  
521 are connected by a general relation "take" 536. The  
relation "take" has two names "taken by" and "take" as  
expression with "degree" as a subject

"degree taken by person", and  
25 as expression with "person" as a subject  
"person took degree".

A relation for linking two specific concepts is  
called specific relation. To generate this relation, the

1 concepts must be connected by a general relation in which  
super concepts thereof have the same relational name.  
For example, concepts "Taro Hitachi" 517 and "bachelor  
of engineering" 523 are connected by a special relation  
5 "take" 537. By this relation, a special fact "Taro  
Hitachi took bachelor of engineering" can be expressed.  
The "relations" for connecting concepts make it possible  
to associably "browse" through the concepts stored in the  
knowledge base. A concept noticed by the user browsing  
10 through concepts is called current concept.

By storing knowledge in the above form,  
inputting of an explanatory sentence and retrieval of a  
special fact from an explanatory query sentence as a  
means of retrieval can be performed as described in U.S.  
15 Patent 4,868,733 and JP-A-1-140,332. For example,  
inputting of fact information "news item #0468 on the  
subject of Creative WS 2050 developed by Hitachi placed  
in Tokyo" and retrieval of the fact information from a  
query formula "News item on the subject of a computer  
20 developed by a company placed in Japan ?" can be per-  
formed. A natural language interface is used when a  
query request is issued in the information retrieval  
system.

In the aforementioned, conventional techniques,  
25 however, expression of knowledge to be registered is  
insufficient as follows.

The first problem is caused by that fact  
knowledge is expressed by binomial relations. When, for

1 example, a fact is expressed by using three or more  
concepts as "Taro Hitachi took bachelor of engineering at  
University A", a plurality of general relations and  
specific relations must be used. For example, as shown  
5 in Fig. 5, "Taro Hitachi" 517 and "bachelor of engineer-  
ing" 523 must be connected by a relation "take" 537 and,  
at the same time, "University A" 513 and "bachelor of  
engineering" 523 must be connected by another relation  
"take at" 539. In this case, there is no proper relation  
10 between "Taro Hitachi" 517 and "University A" 513, so  
that the two concepts must be connected through "bachelor  
of engineering".

When a plurality of things are expressed as  
knowledge, similar things are often confused.

15 For example, for expression of the two things  
"A bought book X at B shop" and  
"A bought magazine Y at C shop",  
the things must be separated into four relations for  
registration

20 "A bought book X",  
"A bought at B shop",  
"A bought magazine Y" and  
"A bought at C shop".

When things are separated into a plurality of  
25 binomial relations as described above, however, there  
arises a problem in that the judgment as to whether the  
shop at which "A" bought "book X" is "B shop" or "C shop"  
cannot be made.

1           The second problem is in that indefinite  
knowledge cannot be registered in the situation such as  
"maybe A company" or "A company or B company". Further-  
more, a set of concepts such as "A set of A company and B  
5   company developed RISC machine" or knowledge such as "A  
company being a computer maker and a semiconductor maker  
developed RISC machine" cannot be registered.

          The third problem is in that facts registered  
in the knowledge base cannot be displayed properly with  
10   respect to a special relation. When, for example, a  
general relation

          "degree taken at university"  
is pointed for display with respect to a relation "take",  
a fact "bachelor of engineering taken at University A"  
15   can be displayed to the user. However, a general rela-  
tion

          "person took degree"  
is not pointed, so that the user cannot know the fact  
"Taro Hitachi took bachelor of engineering" though the  
20   same verb "take" is used.

          The fourth problem arises in the display  
function when the aforementioned problems are solved.  
When the display function is extended so that the  
polynomial relation "Taro Hitachi took bachelor of  
25   engineering at University A" as well as the binomial  
relation can be expressed, the following problem arises  
in the conventional techniques. That is, browsing  
through facts is associative browsing which interacts

1 with frame display of concepts. When, for example, frame  
display with respect to "bachelor of engineering" is  
performed, it can be known from the frame that "bachelor  
of engineering" is "degree" and "taken by Taro Hitachi"  
5 and "taken at University A". When what is "Taro Hitachi"  
is then to be known, the frame with respect to "Taro  
Hitachi" can be examined by pointing "Taro Hitachi"  
through a mouse. However, when the browsing method is  
applied to the knowledge base of polynomial relations,  
10 not only each fact becomes long but a large number of  
facts are displayed. As a result, the merit of a list is  
lowered. Furthermore, similar things may be often  
confused when a plurality of things are displayed. There  
is not yet known any method of providing easy browsing to  
15 the user by properly displaying a large amount of infor-  
mation having a complex structure as described above.

As described above, the conventional techniques  
have various problems. As described above, the conven-  
tional method of displaying knowledge on the basis of  
20 binomial relations has a problem in that fact knowledge  
based polynomial relations cannot be expressed properly.  
Furthermore, semantic defects and problems on display  
arise when display is made forcedly.

We aim to provide a new information storage and  
retrieval system which at least partly overcomes this  
25 problem. It would be desirable to  
provide an extension type concept network model in which  
polynomial relations can be expressed so that semantic



1 information based on polynomial relations can be expressed on a computer according to the model to thereby solve the aforementioned problems.

It would also be desirable to provide  
5 a display method in which a limited view area is utilized so effectively that the user can see the contents of the knowledge base easily to thereby solve the display problems derived from improvement of the knowledge expression capacity.

10 It would also be desirable to easily generate sentences expressed by polynomial relations by using a pointing device.

The invention  
provides an extension type concept network model to  
15 make it possible to express polynomial relations by using "concepts" and "relations" and, at the same time, by the provision of a function for inputting and display of semantic information allowed to be expressed by the model in the form of rearranged data.

20 That is, the present invention provides an information storage and retrieval system using a concept relation model for representing knowledge in terms of concepts and relations defined between the concepts, which comprises: means for selecting a fact concept or a  
25 relational concept used in an input sentence from a conceptual tree (node tree) for concepts which include conceptual concepts expressing things and relational concepts expressing relations defined between the

1 concepts, for extracting candidate sentences allowed to  
use the selected concept by using templates, each of  
which defines semantic information peculiar to the  
relational concepts, information concerning the  
5 conceptual concepts and information concerning preposi-  
tions/postpositions, and for focusing the input sentences  
from the extracted candidate sentences; means for inputt-  
ing fact information according to the structure of the  
templates; means for storing the fact information  
10 inputted by the input means and for retrieving a desired  
concept on the basis of the stored fact information;  
means for displaying a fact window for the fact infor-  
mation, an input window for the semantic information for  
the candidate sentences and the templates, a node tree  
15 window for a hierarchy of the conceptual concepts and the  
relational concepts to perform at least one of the  
focusing of the candidate sentences, the inputting of the  
fact information and the retrieval of the requested  
conceptual concept.

20 The principle and operation of a knowledge  
expression and display method of the present type  
will be described below.

A concept network as the knowledge expression  
method and in the system being an embodiment of the present  
25 invention will be described with reference to Fig. 6 by way of example.

In an extension concept network, "concept"  
representing a thing such as a person's name or a place  
name is expressed and called conceptual concept. In this

1 specification, the conceptual concept is also called  
concept. Besides the concept, "relation" which has been  
heretofore called link is also expressed as a kind of  
"concept" and called relational concept. Relational  
5 concepts are classified into verbal concepts representing  
verbs and attribute concepts representing attributes.  
These relational concepts as well as the conventional  
concepts have is-a relations. Specifically, as shown in  
Fig. 6, "concept" 603 and "relation" 633 rank below the  
10 uppermost concept "UNIVERSAL" 601. Further, "DO rela-  
tion" 635 which is a general name for verbal concepts and  
"BE relation" 643 which is a general name for attribute  
concepts rank below "relation" 633. Further, "get" 637,  
"take" 639 and the like are subsumed under "DO relation"  
15 and "nationality" 645 and the like are subsumed under "BE  
relation".

The relational concepts can have semantic  
information peculiar thereto. Each of the attribute  
concepts can be defined by two concepts as semantic  
20 constituent elements thereof. Each of the verbal con-  
cepts can be defined by two or more concepts as semantic  
constituent elements thereof. A grammar rule H-403  
constituted by a combination of relational concepts and  
concepts as semantic constituent elements is called  
25 template. The semantic roles of the concepts embedded in  
the template are called cases. The relational concepts  
and the concepts are connected by links called case  
links. For example, a template for a verbal concept

1 "get" is expressed in the form of "[intellectual entity]  
[get] [thing] at [organization] in [time]" 648 (Fig. 6).  
This template defines "intellectual entity" 623 as agent  
case representing a subject of action, "thing" 617 as  
5 object case, "organization" 611 as collection-in case and  
"time" 605 as time case, respectively. The concepts  
defined as cases, such as "intellectual entity" and  
"thing", are called case constraint concepts. As a case  
constraint concept, a plurality of concepts can be  
10 defined. One template to each relational concept can be  
defined. The concept allowed to be defined in a case in  
a lower-rank template is a subconcept subsumed under the  
concept defined in a corresponding case in a higher-rank  
template. For example, a template 649 for "take" which  
15 is a subconcept of "get" defines "person" 625 as agent  
case and "license" 619 as object case, respectively, and  
further defines "organization" 613 as collection-in case  
and "time" 607 as time case, respectively, in the same  
manner as the template 648 for "get". The concept  
20 "person" 625 as agent case is a subconcept of "intel-  
lectual entity" 623. A concept dictionary 401 defines  
high-low relations, that is, is-a relations, and part-  
whole relations between concepts. As high-low relations  
between relational concepts, is-a relations are defined.  
25 The concept dictionary is constructed by these relations  
and has a tree structure.

On the other hand, a template for an attribute  
concept "nationality" is expressed in the form of

1 "nationality of [person] is [nation]" 651. Here,  
"person" 625 as an attribute object case representing the  
center of the attribute described and "nation" 629 as an  
attribute value case representing the value of the  
5 attribute are defined as case constraint concepts,  
respectively. A hierarchy can be given to the template  
for an attribute concept by is-a relations in the same  
manner as the template for a verbal concept. As  
described above, frames of fact knowledge to be expressed  
10 can be accumulated as general knowledge by a set of  
templates and concept dictionaries. When, for example, a  
collection-in case is pointed in the template 649 for  
"take", "organization" 611 can be represented as a  
candidate. On the contrary, a template in which  
15 "license" 619 is defined as case constraint concept or  
case in which the concept is defined in the template can  
be retrieved.

Specific knowledge (fact knowledge) to be  
initially stored in the system can be expressed by embed-  
20 ding special concepts in templates therefor and can be  
stored in the knowledge base. For example, in expression  
of a fact "Taro Hitachi took bachelor of engineering at  
University A in 1970" 650 (Fig. 6), "Taro Hitachi" 627 as  
agent case, "bachelor of engineering" 621 as object case,  
25 "University A" 615 as collection-in case and "1970" 609  
as time case are successively embedded in a template for  
"take". In expression of a fact "nationality of Taro  
Hitachi is Japan" 652, "Taro Hitachi" 627 as attribute

- 1 object case and "Japan" 631 as attribute value case are successively embedded in a template for "nationality".

As described above, fact knowledge to be accumulated can be expressed by the structures of  
5 templates given to a verbal concept and an attribute concept, so that the sense thereof can be expressed as data in the inside of the computer. Fact information expressing the fact knowledge is generated as a semantic sentence. The concepts embedded in the templates  
10 representing semantic information are concepts managed in a hierarchical conceptual system, to make semantic retrieval using inference possible as will be described later.

The principle of the knowledge display, query  
15 editing and fact information inputting method as well as the total structure and operation of the information storage and retrieval system using the knowledge expression method will be described below.

Fig. 3 shows an example of functional arrangement of an information storage and retrieval system using  
20 a Concept Network. The user interacts with the system through a display unit 202, a keyboard 203 and a mouse 204. On the basis of user's request, the system performs retrieval and display of necessary information or per-  
25 forms storage and accumulation of fragmentary information inputted by the user in a knowledge base 309 constituted by a Concept Network.

Concept Network data expressed according to a

1 predetermined expression model, such as for example  
information concerning templates, information concerning  
a concept dictionary and information concerning input  
facts and queries, are stored in the knowledge base 309.  
5 The data can be expressed in the form of text, so that  
the data can be exchanged to data in another system. The  
data are read in a memory in a Concept Network Manager  
307 at the time of starting of the system and converted  
into an internal data structure to make high-speed  
10 retrieval possible. The Concept Network data expressed  
by the internal data structure are accessed from a  
Concept Network Editor (CE) 304, a View Generator (VG)  
305 and a Concept Searcher (CS) 306 and processed for  
editing, display and retrieval of knowledge (Concept  
15 Network).

The interaction with the user is controlled by  
an I/O controller 315. The I/O controller is composed of  
a Window Manager (WM) 308 and an Event Analyzer (EV) 311.  
Input information from the keyboard 203 and the mouse 204  
20 is analyzed by the Event Analyzer and processed by an  
interactive view controller 320. The interactive view  
controller is composed of a Concept Network Editing  
Manager (CED) 301, a Browser (BR) 302 and a Query Editor  
(QE) 303. In alteration of information in the knowledge  
25 base, input information is delivered to the Concept  
Network Manager through the Concept Network Editing  
Manager 301 and the Concept Network Editor. Information  
necessary for display is fed from the manager to the View

1 Generator, so that the updated contents of the informa-  
tion are displayed on a multi-window of a display unit  
through the Browser and the Window Manager. In editing  
of query sentences, information is converted into the  
5 form of a sentence using templates by the Query Editor,  
so that information in the manager is retrieved through  
the Concept Searcher.

The present invention is relates to the  
Browser, the Concept Network Editor and the Query Editor.

10 In the following, the operation of the system  
will be described with reference to an example of inter-  
active display shown in Fig. 1. First, the structure of  
the interactive display will be described. The inter-  
active display is composed of a plurality of windows.

15 Basic windows which are continuously displayed are a  
super-concept window 101, a query editing window 102 and  
a node tree window 103. The window 105 shown in Fig. 1  
is a fact window displayed by user's selection. The  
detail of the fact window is shown in Fig. 7.

20 The query process is carried out as follows.  
The query editing function which will be described later  
is performed by the Query Editor 303. When the user  
clicks the mouse 204 to shift the pointer (arrow) in the  
interactive display (Fig. 1) to the query editing window  
25 102, the window is activated so that the user can select  
an arbitrary element in the query to be edited. In Fig.  
1, [company] 107 in the first line in the window repre-  
sents a concept to be retrieved. Sentences 108, 109, 110



1 and 111 in the second line and below the second line are  
conditional sentences to be satisfied by "company" 107.  
The modification relations between the conditional  
sentences are expressed by indentation in the respective  
5 lines as shown in the drawing.

Here, the user can select an arbitrary concept  
(noun) enclosed in brackets ([ ]) and an arbitrary  
conditional sentence through the mouse. When a concept  
enclosed in brackets is pointed, data displayed in the  
10 node tree window 103 are rewritten to a category  
containing the selected concept. When, for example,  
"company" 107 in the query editing window is pointed, the  
node tree in the node tree window is rewritten to a node  
tree containing the concept "company" as shown in Fig. 1.  
15 That is, the system identifies the selected concept from  
the whole concept network, selects a super concept (in  
this case, selects "intellectual entity") including the  
selected concept and displays a category containing the  
concept. For example, at this time, "company" is  
20 highlighted by a rectangle 106. The highlighted concept  
is called current concept.

The super-concept window 101 permits display of  
a row of concepts (in Fig. 1, from "company" 116 to  
"UNIVERSAL" 112) connected upward with respect to the  
25 current concept.

When an arbitrary concept displayed in the node  
tree window is pointed by clicking the left button of the  
mouse, the current concept is replaced by the pointed

1 concept. At the same time, the super-concept window and  
the query editing window are altered correspondingly.  
When, for example, the current concept is altered from  
"company" to "financial business", the super-concept  
5 window 101 is altered so that "financial business" and  
super concepts are displayed. In the query editing  
window 102, "company" 107 is rewritten to "financial  
business". As described above, these basic windows  
operate so as to be linked to one another, so that the  
10 user can edit the query by reference to the contents of  
the knowledge base. For example, a concept which cannot  
be remembered may be remembered by a stimulus that the  
node tree displayed is seen. Furthermore, the category  
as an object of retrieval can be minimized by expressing  
15 the query in terms of concepts as low as possible. The  
time required for retrieval can be shortened as the  
results of retrieval are focused.

Besides the concept rewriting function, the  
following functions are used in query editing. When a  
20 concept enclosed in brackets in a query is pointed by  
clicking the right button of the mouse, a list of  
functions is displayed as a pop-up menu. The list of  
functions contains:

- 1) addition of conditional sentence;
- 25 2) deletion of case; and
- 3) execution of retrieval.

When the head of a conditional sentence is  
pointed by clicking the right button of the mouse, a list

1 of functions is displayed as a pop-up menu. The list of functions contains:

- 4) deletion of conditional sentence; and
- 5) addition of case.

5           The conditional sentence addition function is applied to a pointed concept such as "company" 107. When this function is selected from the menu, a group of relations modifying (restricting) "company" are displayed in another window. For example, a large number of  
10 concepts, "establish" as a verb using "company" as an object case, "have" as a verb using "company" as an agent case, "meet" as a verb using "company" as a collection-in case, and the the like, are listed up. In the case of Fig. 1, the user selects "have" from the list. Because  
15 the list generally contains a large number of relations (conditional clauses expressed in terms of verbal concepts and attribute concepts), the function of focusing concepts to be requested by the user is important. For this end, the function of focusing candidates for  
20 conditional clauses can be provided by performing string matching.

          When the user selected one relation such as a verb "have", the system displays cases limiting the sense of the verb by reference to the template (see Fig. 6)  
25 attached to the verbal concept "have" and inquires of the user what case is used as a condition. For example, the agent case has been determined as "company". Accordingly, other cases such as "collection-in case" and "object

1 case" are listed up and displayed. When the user selects  
the collection-in case and the object case, the following  
sentence is displayed.

"The company has [thing] at [place]"

5 Here, the user can alter "place" to "Shinshu"  
and "thing" to "office" by the aforementioned method, so  
that the conditional sentence 108 can be generated.

The case deletion function is provided to  
loosen the condition. When, for example, the function is  
10 called while pointing the concept "Shinshu" in the condi-  
tional sentence, the conditional sentence 108 can be  
loosened as "The company has [office]".

The query executing function is provided to  
retrieve a pointed concept. When, for example, the  
15 function is called while pointing "company" 107,  
"company" modified (restricted) by conditional sentences  
180, 109, 110 and 111 is retrieved by using classifi-  
cation inference. Besides concepts in the first line,  
the retrieval can be applied to concepts in conditional  
20 sentences in the second line and below the second line.  
When, for example, the query executing function is  
started while pointing the concept "person" 120 in the  
conditional sentence 109 by the mouse, "person published  
essay in magazine" can be retrieved. By using this  
25 function, a judgment can be made as to whether each  
condition is satisfied.

By pointing the head of a conditional sentence  
through the mouse, the conditional sentence can be

1 deleted. Accordingly, the query condition can be loosened.

Furthermore, a new case can be added to the conditional sentence. When, for example, the case  
5 addition function is started while pointing the head of the conditional sentence "The company has [office]", relational concepts in the conditional sentence are displayed in another window, that is, in this case, case structures of the verbal concept "have" are displayed in  
10 another window. Specifically, "at [place]", "in [time]", "for [object]", "by [means]" and the like are displayed. Because initially existing case elements "[intellectual entity]" and "[thing]" have been used in the query, the case elements are indicated so that they cannot be  
15 selected. For example, the user can select "at [place]" so that the conditional sentence can be changed as follows.

"The company has [office] at [place]"

As described above, the condition of the query  
20 can be made more rigorous by this function.

Not only a list of concepts corresponding to the query can be displayed as a result of retrieval, but a sentence generated by substituting specific concepts into the concepts in the query can be displayed as a  
25 result of retrieval. For example, with respect to the query:

- "[company]:?"

It has [office] in [Shinshu].

1           It was rebuilt by [person]." (801), three cases  
of results "Shinshu Realtor Co." 803, "Azuma Co." 804 and  
"Kawase Realtor Co." 805 are displayed in the result list  
window 802 as shown in Fig. 8. When, for example,  
5   "Shinshu Realtor Co." is selected from the concepts  
displayed in the window,

          "Shinshu Realtor Co.

          It has Shinshu Nagano office in Shinshu.

          It was rebuilt by Taro Hitachi." (811) is  
10   displayed in the result browser window 810. Here,  
      "Nagano City" 812, "Shinshu Nagano office" 813 and "Taro  
Hitachi" 814 are specific concepts in the knowledge base,  
which satisfy the conditions in the query. In this case,  
it is necessary that the following facts are registered  
15   as fact knowledge in the knowledge base.

          "Shinshu Realtor Co. is company"

          "Shinshu Nagano office is office"

          "Taro Hitachi is person"

          "Nagano City is a part of Shinshu"

20       "Shinshu Realtor Co. has Shinshu Nagano office  
in Nagano City"

          "Shinshu Nagano office was rebuilt by Taro  
Hitachi".

          The above retrieval can be realized by an  
25   inference retrieval process in which classification  
inference is called. With respect to the specific method  
of realizing the inference process, for example, a method  
as disclosed in Masato Shibazaki et al. "Case Structure

1 Data Base using Natural Language Semantic Information as  
an Object", Information Processing Society, Fundamental  
Infology Study Meeting Material (SIGFI) No. 21-5 (May 28,  
1991) can be used.

5 A characteristic function in this invention is  
a function of displaying more detailed information in a  
fact window by pointing an arbitrary concept in the  
result display shown in Fig. 8. For example, relational  
facts can be displayed in the fact window 700 shown in  
10 Fig. 7 by pointing "Taro Hitachi" 814. The window has a  
concept name as a label 701 expressing a concept provided  
therein. Data displayed in the window are attribute  
facts and verbal facts for the concept. The facts are  
displayed in tabular form in an attribute fact area 702  
15 and a verbal fact area 703, respectively.

Attribute facts are expressed by attribute  
names 712, 714, 716 and 718 and corresponding attribute  
values 713, 715, 717. Because attribute facts have  
binomial relations, the facts must be displayed  
20 bidirectionally. For example, "Taro Hitachi" may be  
registered as an attribute value of another concept as  
well as the attribute of "Taro Hitachi" as follows.

"Nationality of Taro Hitachi is Japan", and  
"Designer of Katagiri's residence is Taro  
25 Hitachi"

Accordingly, as a knowledge display function,  
bidirectional display is required. Each of the symbols  
">>" and "<<" provided to attribute names indicates a

1 direction in the binomial relation.

Verbal facts are displayed in tabular form as shown in Fig. 7. For example, verbal facts are displayed as follows: "Taro Hitachi graduated from University A in 1970"; "Taro Hitachi took doctorate at University B in 1975"; and "(SET:Taro Hitachi;Yoshio Tanaka) established office in Kobuchizawa". Herein, (SET:X;Y) 720 represents a sum set of concept X and concept Y. In this case, the latter sentence expresses

10 "Taro Hitachi and Yoshio Tanaka together established office".

Serial number for fact is displayed in the head of each fact. As shown in Fig. 7, number 7111 is "4" and, on the other hand, number 710 is "6". That is,

15 number "5" is not displayed. This shows that a fact "Taro Hitachi took ..." identified by number "5" exists. As described above, when a large number of facts are provided, the outline thereof can be exhibited to the user so that it is easy to understand, by hiding (not

20 displaying) similar facts. This method is a display method for effectively utilizing a display having a limited area.

In the following, the principle of inputting of facts and queries will be described.

25 A flow chart of a process for inputting one sentence is shown in Fig. 4 on the basis of relations between concept dictionaries and grammar rules of templates.



1                   When, for example, a fact

                  "Taro Hitachi took bachelor of engineering at  
                  University A"

is to be inputted in a knowledge base, one of concepts

5    "Taro Hitachi", "University A", "bachelor of engineering"

and "take" is selected from a concept dictionary at

concept selection 405. Assuming now that "take" is

selected, then cases to be used are selected from a

template for "take" at case selection 415 because it is

10 unnecessary to perform candidate extraction 407, focusing

409 and candidate display 411. In this case, agent case,

collection-in case and object case are pointed. Because

case constraint concepts registered in the template have

been respectively placed in these cases, subconcepts

15 subsumed under the case constraint concepts are respec-

tively selected, as concepts to be put in the cases, from

the concept dictionary. In this case, "Taro Hitachi",

"University A" and "bachelor of engineering" are selected

as agent case, collection-in case and object case,

20 respectively. Then, the selected concepts are displayed

(417) after work order, inclusive of prepositions/

postpositions, is rearranged on the basis of a grammar

rule.

                  When, for example, a query

25                   "person which took bachelor of engineering at

                  University A ?"

is to be inputted, "take" may be selected in the same

manner as described above to thereby perform the input-

1   ting of the query or conditions given to "person" may be  
listed so that selection from the conditions can be made.  
In the latter case, "person" as an object of retrieval is  
first selected at concept selection (405). Then, condi-  
5   tions given to "person" are extracted and displayed as a  
list at candidate extraction 407. Relations in which  
super concepts of "person" in the concept dictionary are  
set as case constraint concepts of templates are  
extracted from relations registered as grammar rules and  
10   are displayed to thereby make it possible to perform  
candidate extraction.

When a large number of candidate sentences are  
provided, focusing 409 can be performed. For example,  
relations having cases allowed to be filled with  
15   "bachelor of engineering" are selected from the list of  
relations displayed, so that candidate display 411 can be  
performed by rearranging the prescribed form by using the  
selected relations.

In sentence selection 413, relations used in a  
20   sentence to be inputted among candidate sentences are  
selected. Cases to be used are selected from cases in  
the selected relations and concepts to be inputted in the  
cases are selected at case selection 415 and sentence  
display 417 in the same manner as the inputting of  
25   sentences in the knowledge base.

In selection of concepts to be inputted into  
cases at case selection 415, concepts subsumed under case  
constraint concepts, selected in the concept dictionary,

1 are displayed in one window to aid concept selection.

A sentence modifying a concept in an input sentence can be provided by repeating the above procedure through selecting the concept from the input sentence at  
5 concept selection 405.

As described above, fact information for concepts and relations registered in the knowledge base can be displayed or inputted.

In the drawings;

10 Fig. 1 is a view showing an example of display for visual expression of knowledge in an information storage and retrieval system according to the present invention;

Fig. 2 is a view showing a system arrangement  
15 of a filing system using the information storage and retrieval system;

Fig. 3 is a view showing a module arrangement of the information storage and retrieval system;

Fig. 4 is a view showing a flow of the sentence  
20 generating routine;

Fig. 5 is a view showing an example of conventional knowledge expression;

Fig. 6 is a view showing an example of knowledge expression according to the present invention;

25 Fig. 7 is a view showing an example of display of facts expressed in terms of a pointed concept "Taro Hitachi";

1           Fig. 8 is a view showing an example of display  
of a result retrieved by a retrieval function of the  
information storage and retrieval system;

          Fig. 9 is a view showing a data structure of  
5   concept information in a knowledge base;

          Fig. 10 is a view showing a data structure of  
verbal concept information in the knowledge base;

          Fig. 11 is a view showing a data structure of  
template information for a verbal concept "take" in the  
10   knowledge base;

          Fig. 12 is a view showing a data structure of  
fact information "Taro Hitachi took doctorate at  
University A in 1975" expressed by a verbal concept in  
the knowledge base;

15           Fig. 13 is a view showing a data structure of  
fact information "Taro Hitachi and Taro Tanaka estab-  
lished office at Kobuchizawa" expressed by a verbal  
concept in the knowledge base;

          Fig. 14 is a view showing a data structure of  
20   template information for an attribute concept  
"nationality" in the knowledge base;

          Fig. 15 is a view showing a data structure of  
fact information "Nationality of Taro Hitachi is Japan"  
expressed by an attribute concept in the knowledge base;

25           Fig. 16 is a view showing a data structure in  
which verbal facts expressed by a pointed concept "Taro  
Hitachi" are developed on a memory by reference to the  
semantic priority order of cases;

1           Fig. 17 is a view showing a data structure in  
which view data of representative facts are reconstructed  
by grouping developed facts by verbal concepts;

          Fig. 18 is a view showing a data structure in  
5   which super concepts are developed on a fact information  
view memory;

          Fig. 19 is a view showing a data structure in  
which attribute facts expressed by a pointed concept are  
extracted by reference to the semantic priority order of  
10 cases and developed to be added to the data structure of  
Fig. 18;

          Fig. 20 is a view showing a data structure in  
which the facts developed in Fig. 19 are grouped by  
attribute concepts and reconstructed;

15           Fig. 21 is view showing a data structure in  
which view data of facts initially displayed in the view  
data in Fig. 17 are developed;

          Fig. 22 is a view showing a data structure in  
which the view data of facts selected in Fig. 35 are  
20 added to the view data in Fig. 21;

          Fig. 23 is a view showing a state in which  
information concerning a pointed concept is held;

          Fig. 24 is a view showing a state in which  
information concerning a sentence due to attributes is  
25 held;

          Fig. 25 is a view showing a state in which  
information concerning a template for attributes is held;

          Fig. 26 is a view showing a state in which

1 information concerning a sentence due to relations is  
held;

Fig. 27 is a view showing a state in which  
information concerning a template for relations due is  
5 held;

Fig. 28 is a view showing a state in which  
information for retrieving templates allowed to use a  
pointed concept is held;

Fig. 29 is a view showing display at browsing  
10 through fact information expressed by a pointed verbal  
concept "take";

Fig. 30 is a view showing an example of display  
of facts expressed by a pointed verbal concept "take";

Fig. 31 is a view showing display at browsing  
15 through fact information expressed by a pointed attribute  
concept "nationality";

Fig. 32 is a view showing an example of display  
of facts expressed by a pointed attribute concept  
"nationality";

20 Fig. 33 is a view showing display of facts for  
"take" in which "Taro Hitachi" is registered as an agent  
case;

Fig. 34 is a view showing an example of display  
of facts for "take" in which "Taro Hitachi" is registered  
25 as an agent case;

Fig. 35 is a view showing an example of display  
of facts after an addition button is selected in the  
display of facts as shown in Fig. 34;

1           Fig. 36 is a view showing an example of display  
of facts after the fact selected in Fig. 35 is added;

          Fig. 37 is a view showing an example of display  
of facts expressed by a pointed concept "person" and  
5   subconcepts thereof;

          Fig. 38 is a view showing display at browsing  
through fact information for a verbal concept "take" and  
a concept "Taro Hitachi";

          Fig. 39 is a view showing display at browsing  
10 through fact information for an attribute concept  
"nationality" and a concept "Taro Hitachi";

          Fig. 40 is a view showing display at browsing  
through fact information for concepts "Taro Hitachi" and  
"Japan";

15           Fig. 41 is a view showing an example of display  
of the full sentence of a pointed fact;

          Fig. 42 is a view of a group of view windows at  
the time of sentence generation in an embodiment of the  
present invention;

20           Fig. 43 is a view of the case where a parti-  
cipial modification sentence is generated;

          Fig. 44 is a view showing a display state in  
which a plurality of anchor concepts are provided;

          Fig. 45 is a view showing a display state in  
25 which the query condition is initialized;

          Fig. 46 is a view showing an example of display  
in which candidate sentences are provided;

          Fig. 47 is a view of a window for selecting

1 sentences and cases;

Fig. 48 is a view showing an example in which focusing is performed twice;

5 Fig. 49 is a view showing an example of a query editing window in which one line is added;

Fig. 50 is a view showing an example of display at the time of alteration of a case element;

Fig. 51 is a view showing an example of display of query conditions in which a plurality of concepts are  
10 contained in a conditional sentence;

Fig. 52 is a view showing an example of display of results by a retrieval function of the information storage and retrieval system;

Fig. 53 is a view showing a flow of the concept  
15 and relation fact information display routine;

Fig. 54 is a view showing a flow of the case where nodes are classified by kind in the concept and relation fact information display routine;

Fig. 55 is a view showing a flow of the case  
20 where view data are generated in the concept fact information display routine;

Fig. 56 is a view showing a flow of the case where view data of verbal facts are generated in the concept fact information display routine;

25 Fig. 57 is a view showing a flow of the case where facts are grouped by relational concepts to discriminate between view and non-view in the concept fact information display routine;



1            Fig. 58 is a view showing a flow of the case  
where view data of attribute facts are generated in the  
concept fact information display routine;

            Fig. 59 is a view showing a flow of the case  
5    where view positions are determined in the verbal fact  
display routine;

            Fig. 60 is a view showing a flow of the case  
where view positions are determined in the verbal fact  
display routine;

10           Fig. 61 is a view showing a flow of the case  
where view positions of strings of characters for a  
preposition/postposition and a concept are determined in  
the verbal fact display routine;

            Fig. 62 is a view showing a flow of the case  
15    where view positions are determined in the routine for  
displaying is-a relations and part-whole relations  
between concepts and attribute facts;

            Fig. 63 is a view showing a flow of the routine  
for displaying fact information of verbal concepts;

20           Fig. 64 is a view showing a flow of the routine  
for displaying fact information of attribute concepts;

            Fig. 65 is a view showing a flow of the case  
where view data are generated in the routine for  
displaying fact information of attribute concepts;

25           Fig. 66 is a view showing a flow of the query  
editing routine;

            Fig. 67 is a view showing a flow of the query  
editing routine;

1           Fig. 68 is a view showing a flow of the query  
editing routine;

          Fig. 69 is a view showing a flow of the query  
editing routine;

5           Fig. 70 is a view showing a flow of the query  
editing routine;

          Fig. 71 is a view showing a flow of the query  
editing routine; and

          Fig. 72 is a view showing a flow of the query  
10 editing routine.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

          The structure and operation of the system will  
be outlined below with reference to the drawings.

          Fig. 2 is a system arrangement of an infor-  
15 mation storage and retrieval system according to an  
embodiment of the present invention. The system com-  
prises a control unit 201, a main memory 205, magnetic  
disk units 206, a display unit 202, a keyboard 203 and a  
mouse 204. The system permits inputting of significant  
20 information into a knowledge base (which is stored in the  
magnetic disk units 206 or the like), storage of specific  
information or knowledge and retrieval thereof. Data are  
read from the knowledge base (stored in the magnetic disk  
units 206) and memorized in the main memory 205. Using  
25 the display unit 202, the keyboard 203 and the mouse 204,  
information (concerning concepts, relations and facts)  
registered in the knowledge base is requested as an

1 object to be displayed, so that the retrieval result is  
displayed on the display unit 202. The knowledge base  
has Concept Network data as represented according to a  
predetermined representation model, that is, information  
5 concerning templates, information concerning concept  
dictionaries and information concerning input facts and  
queries. The knowledge base is stored in a text file.

The operation of the system will be outlined  
below by referring to Figs. 9 through 28 (which show the  
10 data structure in the inside of the system), Figs. 7, 8  
and 29 through 52 (which show examples of displayed data)  
and Figs. 53 through 72 (which show flow PAD.

Data expressing fact information are generated  
by referring to knowledge stored in the memory. The  
15 knowledge contains:

- 1) concept data,
- 2) template data,
- 3) relation data, and
- 4) fact data.

20 The structures of these data will be described below.  
Referring to Fig. 3, text-form information stored in the  
knowledge base 309 is expanded on the main memory through  
a Concept Network Manager 307 and managed as a data  
structure according to a polynomial relation model.

25 The information is managed under ID data. The  
concept and relation ID data, the template ID data and  
the fact ID data are stored in a node management table  
(not shown), a template management table (not shown) and

1 a fact management table (not shown), respectively.

"Node" used herein is a general term for concepts and relations. In the following, sequencing of significant information will be described below.

5 5) sequencing of significant information

In this embodiment, "case link" (significant information) is classified into "attribute object (AO) case" and "attribute value (AV) case" by attribute concepts and classified into eleven, i.e., "time (TI)  
10 case", "agent (A) case", "collection in (CI) case", "recipient (R) case", "object (O) case", "collection from (CF) case", "collection to (CT) case", "reason (W) case", "instrument (I) case", "purpose (U) case" and "quantity (Q) case", by verbal concepts.

15 Firstly, the data structure of concept and fact information for a concept "Taro Hitachi" is shown in Fig. 9. A concept table 902 comprises a node ID 903 for the concept "Taro Hitachi", a pointer 905 for a name table list, a pointer 908 for a super-concept table, a pointer  
20 911 for a sub-concept table, a pointer 912 for a whole-concept table, a pointer 913 for a part-concept table, a pointer 915 for a template information table, and a pointer 955 for a fact information table. A pointer 901 from a node management table is connected to the concept  
25 table.

The name table 906 stores a string of characters "Taro Hitachi". If another expression, for example, "Hitachi, T." is registered as a synonym, another name

1 table may be used so that the string of characters  
"Hitachi, T." can be stored. That is, the given concept  
can be stored as the two names, "Taro Hitachi" and  
"Hitachi, T.".

5 The super-concept table 909 stores "person"  
910. This shows that "person" is a super concept for  
"Taro Hitachi". Each of the pointer 911 for the sub-  
concept table, the pointer 912 for the whole-concept  
table and the pointer for the part-concept table is  
10 NULL. This shows that "Taro Hitachi" has no sub-concept,  
no whole-concept and no part-concept in the knowledge  
base.

In the management of templates in template  
information tables 916, 921 and 926, templates in which  
15 the concept can be expressed as agent (A) case 917,  
recipient (R) case 922, attribute object (AO) case 927 or  
the like are classified by cases. In this embodiment,  
templates in which the concept "Taro Hitachi" can be  
expressed as agent (A) case are templates identified by  
20 ID data 5, 14, 36, etc. Templates in which the concept  
"Taro Hitachi" can be expressed as recipient (R) case are  
templates identified by ID data 27, etc. Templates in  
which the concept "Taro Hitachi" can be expressed as  
attribute object (AO) case are templates identified by ID  
25 data 8, etc.

In the management of fact information in fact  
information tables 956, 961 and 966, facts really  
expressed by the concept are classified by cases in the

1 same manner as in template information. In this  
embodiment, facts in which the concept "Taro Hitachi" is  
expressed as agent (A) case 956 are facts identified by  
ID data 26, 64, 85, etc. Facts in which the concept  
5 "Taro Hitachi" is expressed as recipient (R) case 962 are  
facts identified by ID data 215, etc. Facts in which the  
concept "Taro Hitachi" is expressed as attribute object  
(AO) case 967 are facts identified by ID data 29, etc.

Secondly, the data structure of template  
10 information for a verbal concept "take" is shown in Fig.  
11. A template table 1102 comprises a template ID data  
1103, a node ID data 1104 for the verbal concept, a  
pointer 1110 for a case constraint table, a pointer 1145  
for a fact-id table, and pointers 1150 and 1155 for  
15 pattern tables. A pointer 1101 from the template  
management table is connected to the template table.

The fact-id table 1146 stores ID data for facts  
expressed by the verbal concept. In this embodiment,  
facts to be retrieved are facts identified by ID data 26,  
20 64, etc. Case constraint tables 1111, 1114, 1117 and  
1120 are composed of cases, such as agent (A) case 1112,  
expressing the meaning of the verbal concept, and  
pointers 1130, 1133, 1136 and 1140 for case slot filler  
tables to manage concepts defining the cases. In this  
25 embodiment, significant information for the verbal  
concept "take" is classified into agent (A) case 1112,  
object (O) case 1115, time (TI) case 1118 and collection  
in (CI) case 1121. Concepts providing these cases are

1 "person" 1132 in the agent (A) case, "degree" 1135 in the  
object (O) case, "time" 1138 in the time (TI) case and  
"organization" 1142 in the collection in (CI) case.

The pattern table is maintained so that  
5 significant information for a fact can be displayed so as  
to be easy to understand when the fact is expressed in  
the form of a sentence. Patterns for verbal facts are  
classified into "active" and "passive". The former is a  
pattern style adapted for use of the agent (A) case as a  
10 formal subject. The latter is a pattern style adapted  
for use of the object (O) case or the recipient (R) case  
as a formal subject. In the drawing, the verbal concept  
"take" has agent (A) case and object (O) case as signifi-  
cant information. Accordingly, there are two patterns,  
15 i.e., pattern 1151 using the agent (A) case as a formal  
subject and pattern 1155 using the object (O) case as a  
formal subject. The pointer 1158 for the pattern using  
the recipient (R) case as a formal subject is NULL.

In the pattern table 1151 using the agent (A)  
20 case as a formal subject, the sequence of cases and  
verbal concepts and the character strings of prepositions  
and postpositions added to the cases and concepts are  
managed. When, for example, a Japanese template "hito ga  
toki ni gakui wo soshiki de shutokusuru" (in English,  
25 "person takes degree at organization in time") is given,  
"ga", "wo" and "ni" are postpositively added to the  
concept "hito (person)" in the agent (A) case, the  
concept "gakui (degree)" in the object (O) case and the

1 concept "toki (time)" in the time (TI) case. When, for  
example, an English template "person takes degree in  
time" is given, "in" is prepositively added to the  
concept "time" in the time (TI) case but nothing is added  
5 to the concept "person" in the agent (A) case and the  
concept "degree" in the object (O) case. That is, though  
a given case is used in one sense, it can be thought of  
that a postposition may be added to the concept expres-  
sing the case in Japanese but a preposition may be added  
10 to the concept in English and that neither postposition  
nor preposition may be added thereto. The judgment as to  
whether addition of preposition/postposition is required  
varies according to the language used. For the purpose  
of preserving the pattern information regardless of the  
15 language, a set of prepositions and postpositions is  
stored for each case. In this embodiment, preposition/  
postposition tables 1161, 1166, 1171, 1176 and 1181 are  
allocated in the order of agent case 1161, time case  
1167, object case 1172, collection in case 1177 and  
20 relation 1182, so that these are displayed in this order.  
Strings of characters for prepositions/postpositions  
added to concepts expressing cases and relational concept  
are also stored in the preposition/postposition tables.  
In this embodiment, prepositions "at" 1178 and "in" 1168  
25 are added to the concepts expressing the collection-in  
case and the time case, respectively. On the other hand,  
the strings of characters 1164, 1184, 1174, 1179 and 1169  
for postpositions are all "-". This shows that no post-



1 position is added to each case. The strings of characters 1163, 1183 and 1173 for postpositions are all "-". This shows that no preposition is added thereto. Accordingly, when the agent case is used as a formal  
5 subject, the template is displayed as "person takes degree in time". The pattern table 1156 using the object case as a formal subject shows that facts are displayed in the order of object case 1191, relational concept 1199, agent case 1195, collection-in case 1197 and time  
10 case 1193 and that prepositions added to concepts expressing the cases are "by" 1196, "at" 1198 and "in" 1194, respectively.

Thirdly, the data structure of concept information and fact information for a verbal concept  
15 "take" is shown in Fig. 10. A verbal concept table 1002 comprises a node ID data 1103 for the verbal concept "get", a pointer 1104 for a name table for relations, a pointer 1020 for a super-concept table, a pointer 1023 for a sub-concept table, a pointer 1025 for a template-id  
20 table, and a pointer 1030 for a fact-id table. A pointer 1001 from the node management table is connected to the verbal concept table in the same manner as in the concept table. In the drawing, the verbal concept "get" 1022 is a super concept for the verbal concept "take". The  
25 drawing further shows that the ID data 1027 for the template expressed by the verbal concept is 5 and that the ID data 1032 for facts are 26 and so on.

The name table 1005 for relations comprises a

1 string of characters 1006 for "take", and a pointer 1010  
for a name table for voice and tense. The verbal concept  
has different names according to (active/passive) voice  
and (past/present/future) tense. Accordingly, strings of  
5 characters for names given to relations classified by a  
set of voice and tense are managed on the name table 1011  
for voice and tense. When, for example, the voice is  
active and the tense is past, the name for "take" is  
given by a string of characters "take" 1014 corresponding  
10 to the active voice 1012 and the past tense 1013 in the  
first line of the name table 1011 for voice and tense.

Fourthly, the data structure of fact information for a verbal fact expressed on the basis of  
concept, verbal concept and template information  
15 preserved as described above is shown in Figs. 12 and 13,  
Fig. 12 shows the data structure of the following fact:

"Taro Hitachi took doctorate at University B in  
1975".

A fact information table 1202 comprises a fact  
20 ID data 1203, a template ID data 1204, a node ID data  
1205 for a verbal concept, a tense data 1206, and a  
pointer 1210 for a case information table. A pointer  
1201 from the fact management table is connected to the  
fact information table.

25 The case information table 1211 comprises a  
case name 1212, and a pointer 1230 for a case filled  
concept table for the case. For example, "Taro Hitachi"  
1232, "doctorate" 1235, "1975" 1238 and "University B"

1 1241 are concepts expressing agent case 1212, object case  
1215, time case 1218 and collection-in case 1221, respec-  
tively.

When one case is expressed by a plurality of  
5 concepts, for example, when a fact "Taro Hitachi and  
Yoshio Tanaka established office in Kobuchizawa" is  
written, a plurality of case filled concept tables are  
allocated for one case information table (see Fig. 13).  
In the drawing, case filled concept tables 1331 and 1334  
10 for "Taro Hitachi" 1332 and "Yoshio Tanaka" 1335 are  
allocated for one case information table 1311 expressing  
agent case 1302.

On the other hand, concept information, tem-  
plate information and fact information for an attribute  
15 concept can be expressed by data structures similar to  
those for the verbal concept. For example, the data  
structure of template information for an attribute  
concept "nationality" is shown in Fig. 14. Like the  
template information for the verbal concept, a template  
20 table 1402 comprises a template ID data 1403, a node ID  
data 1404 for the attribute concept, a pointer 1410 for a  
case constraint table, a pointer 1435 for a fact-id  
table, and pointers 1440 and 1445 for pattern tables. A  
pointer 1401 from the template management table is  
25 connected to the template table.

The attribute concept always has two cases  
(attribute object case and attribute value case) as  
significant information. Accordingly, the case

1 constraint tables 1411 and 1414 are allocated for the  
attribute object case 1412 and the attribute value case  
1415. In the drawing, concepts providing these cases are  
"person" 1422 in the attribute object case and "nation"  
5 1425 in the attribute value case.

The attribute fact pattern is classified into  
two, namely, object and value. The former is a pattern  
using the attribute object case as a formal subject. The  
latter is a pattern using the attribute value case as a  
10 formal subject. As described above, the attribute  
concept always has two cases, i.e., attribute object case  
and attribute value case, as significant information.  
Accordingly, the attribute concept has two patterns which  
are referred to as pattern 1441 using the attribute  
15 object case as a formal subject and pattern 1446 using  
the attribute value case as a formal subject. In the  
pattern using the attribute object case as a formal  
subject, the relational concept 1457, the attribute  
object case 1452, the complement 1467 and the attribute  
20 value case 1462 are allocated to the preposition/  
postposition tables 1456, 1451, 1466 and 1461 in order.  
The word "complement" used herein means a string of  
characters for complementing the significant structure  
among the attribute concept and the two case slot fillers  
25 when an attribute fact is expressed in the form of a  
sentence. In this embodiment, "of" and "is" are used as  
a preposition added to the concept of the attribute  
object case and a complement, respectively. On the other

1 hand, the strings of characters 1458, 1459, 1454, 1469,  
1463 and 1464 for prepositions/postpositions are all "-".  
This shows that the prepositions/postpositions are not  
added thereto. Accordingly, the template using the  
5 attribute object case as a formal subject is expressed as  
"nationality of person is nation".

The data structure of fact information for an  
attribute fact expressed on the basis of concept,  
attribute concept and template information preserved as  
10 described above is shown in Fig. 15. This drawing shows  
the data structure of the following fact:

"nationality of Taro Hitachi is Japan".

Like the data structure of the verbal fact, the  
data structure comprises a fact information table 1502, a  
15 fact ID data 1503, a template ID data 1504, a node ID  
data 1505 for an attribute concept, a tense information  
1506, and a pointer 1510 for a case information table. A  
pointer 1501 from the fact management table is connected  
to the fact information table.

20 Like the case information table for the verbal  
fact, the case information table 1511 comprises a case  
1512 expressing a fact, and a pointer 1530 for a case  
filled concept table in the case. For example, the  
concepts expressing the attribute object case 1512 and  
25 the attribute value case 1515 are "Taro Hitachi" and  
"Japan", respectively.

Fifthly, the sequencing of significant  
information will be described below. When facts in fact

1 information in which a concept is registered are to be  
displayed in order of importance of the concept, the  
importance of the case expressing a sense is required to  
be referred to. Therefore, sequencing of significant  
5 information is performed so that the information is  
memorized in the form of a list of binary trees.  
Specifically, sequencing of cases with respect to the  
verbal concept is performed in order of agent case,  
object case, recipient case,... so that the cases are  
10 stored in the list of binary trees. Sequencing of cases  
with respect to the attribute concept is performed in  
order of attribute object case and attribute value case  
so that the cases are stored in the list of binary trees.  
Hereinafter, the list is called "case priority list".

15 The display of fact information for a concept  
will be described below as a first embodiment according  
to the display method of the present invention. A method  
of generating display data by referring to fact infor-  
mation for a concept stored in a memory will be described  
20 below.

When a user clicks a concept in a node tree and  
then selects an item from a function list in a pop-up  
menu displayed, a fact window is displayed.

For example, a fact window (see Fig. 7) for a  
25 concept "Taro Hitachi" is displayed as follows. When a  
user clicks a concept "Taro Hitachi" in the displayed  
node tree through a mouse in step 5300 (see Fig. 53), the  
system takes a mouse event in step 5310 and detects a

1 node ID data of a node corresponding to the clicked area  
in step 5320. Then, in step 5330, the kind of the node  
is judged by inquiring of the knowledge base in the  
Concept Network Manager on the basis of the node ID data  
5 detected in the step 5320. In step 5340, a pop-up menu  
corresponding to the kind of the node thus judged is  
displayed. In step 5350, the user selects an item from a  
function menu displayed as the pop-up menu and then the  
situation of the routine goes to step 5400. In step 5410  
10 (see Fig. 54), a judgment is made as to whether the fact  
window required has been already displayed. When the  
window has not been displayed yet, fact information in  
which nodes have been registered is extracted from the  
knowledge base according to the kind of the node judged  
15 in the step 5330, to thereby generate display data. In  
this embodiment, the kind of the node is concept, so that  
the situation of the routine goes to step 5500.

Initially, in step 5510, a list of fact ID data  
for verbal fact to be displayed and a total number  
20 counter are initialized and, in step 5515, a list of fact  
ID data for attribute fact to be displayed and a total  
number counter are initialized.

In step 5520, a case which is a head data is  
picked up from a case priority list for a verbal concept.  
25 The data is agent case. The pointer of the list is not  
NULL, so that the situation of the routine goes to step  
5525. In this step, a judgment is made as to whether  
there is any verbal fact accumulated as agent case, while

- 1 tracing the pointer 901 (see Fig. 9) from the node  
management table to the concept table for the concept and  
the pointer 955 to the fact information table on the  
basis of the node ID data for the concept "Taro Hitachi".
- 5 There is some fact in which "Taro Hitachi" is registered  
in the agent case, so that the situation of the routine  
goes to step 5600.

Then, in step 5610 (see Fig. 56), the case  
management table 1602 is allocated (see Fig. 16) so that  
10 the pointer 1601 from the fact window table is connected  
to the case management table.

- Then, a view table 1604 for fact is generated  
to store information to display a fact therein, so that  
the pointer 1603 from the case management table is  
15 connected to the view table 1604. The view table for  
fact comprises a fact ID data 1610, a template ID data  
1609 of a verbal concept for the fact, a tense 1608 of a  
relational concept, a relational name 1607, a display/  
not-display flag, a positional data, and a pointer for a  
20 view table for case. Counters provided correspondingly to  
the number of facts in which "Taro Hitachi" is registered  
as agent case are initialized and then the situation of  
the routine goes to step 5620. There is some fact  
expressed by "Taro Hitachi", so that the situation of the  
25 routine goes to step 5625. In the step 5625, the fact ID  
data 972 stored in the table 971 is referred to while  
tracing the pointer 970 from the fact information table  
956 for the agent case to the fact-id table (see Fig. 9).



1 Then, a list of binary trees is allocated so separately  
that the fact ID data is stored as a head data in the  
list. Then, the fact ID data 975 in the next fact-id  
table 974 is referred to and stored as the next data in  
5 the list of binary trees. Thus, a list of binary trees  
of fact ID data for verbal facts in which "Taro Hitachi"  
is registered as agent case is generated.

Then, in step 5630, a judgment is made as to  
whether the fact ID data in the list of binary trees  
10 generated in the step 5625 is contained in the list of  
fact ID data for the verbal fact to be displayed. In  
this embodiment, there is no overlapped fact ID data, so  
that the situation of the routine goes to step 5640. In  
this step, the list of fact ID data (or the list obtained  
15 by excluding the fact ID data in step 5635 when there is  
any overlapped fact ID data) generated in the step 5625  
is added to the list of fact ID data for the fact to be  
displayed.

Then, in step 5645, the number of retrieved  
20 facts is added to the counter expressing the total number  
of verbal facts.

Then, the situation of the routine goes to step  
5650. In this embodiment, the concept "Taro Hitachi" has  
no subconcept, so that the situation of the routine goes  
25 to step 5680.

Then, in step 5685, verbal concept information,  
template ID data, fact ID data, tense information and so  
on are stored in a corresponding view table for fact on

1 the basis of the list of binary trees. When, for  
example, the fact identified by the fact ID data 85 is  
the third data in the list of binary trees, the ID data  
is stored in the fact ID area 1610 in the view table 1606  
5 allocated as the third view table for fact (see Fig. 16).  
Then, the pointer 1201 to a fact information table 1202  
corresponding to the fact ID data is traced by referring  
the fact management table (see Fig. 12). Further, tem-  
plate ID data and tense information are respectively  
10 stored in the template ID area 1609 and the tense infor-  
mation area 1608 in the view table for fact by referring  
the template ID data 1204 and the tense information 1206.  
The pointer to a verbal concept table 1002 corresponding  
to the ID data by referring to the node management table  
15 after referring to the verbal concept ID data 1205 (see  
Fig. 10). The pointer 1004 from the table 1002 to a name  
table for relations is traced so that the name "take"  
1006 relational to the verbal concept is referred to.  
The relational name is stored in the relation name area  
20 1607 in the view table 1606 for fact, whereafter the  
situation of the routine goes back to the step 5680.

This procedure is repeated before the pointer  
of the list of binary trees of the fact ID data for facts  
in which "Taro Hitachi" is registered as agent case  
25 changes to NULL. Thus, a corresponding view table for  
fact is generated.

After the view table for fact with respect to  
agent case is generated as described above, view tables

1 for fact are generated in order of the priority of cases,  
for example, in order of the object case, the recipient  
case, ... .

The situation of the routine goes back to the  
5 step 5520, so that the step 5525 is carried out with  
respect to the object case. Because the concept "Taro  
Hitachi" has no fact registered as object case, the  
situation of the routine goes back to the step 5520  
without generation of the case management table for  
10 object case. Then, a case management table 1620 for  
recipient case is generated because the fact for  
recipient case is registered (see Fig. 16). The view  
tables for fact with respect to verbal facts registered  
as respective cases are allocated as described above,  
15 whereafter the situation of the routine goes back to the  
step 5535. The number of verbal facts is stored in the  
fact window table.

Then, the situation of the routine goes to step  
5700 (see Fig. 57) in which the view tables for fact are  
20 classified into groups by verbal concepts to reconstruct  
the list. Specifically, in step 5710, the pointer from  
the case management table to a view table for fact is  
traced (see Fig. 17). Because the pointer is not NULL,  
the situation of the routine goes to step 5720.

25 In this step, facts are classified into groups  
by verbal concepts. Initially, in step 5725, by refer-  
ring to the verbal concept "take" in the view table 1723  
for fact, a judgment is made as to whether there is any

1 case order table allocated for the verbal concept.  
Because there is no table allocated, the situation of the  
routine goes to step 5760. The case order table 1703 is  
allocated for the verbal concept so that the pointer 1702  
5 from the case management table is connected to the table  
1703.

The case order table 1703 comprises a pointer  
1716 to a view table for a fact expressed by the same  
verbal concept, the number 1707 of the facts, and forward  
10 and backward pointers 1705 and 1706 between case order  
tables and so on. Facts corresponding to the view table  
for fact to which the pointer from the case order table  
is connected are displayed when the window is displayed  
initially.

15 In the display of fact information for the  
concept "Taro Hitachi" in this embodiment, it is now  
assumed that the number of verbal facts registered is  
larger than a threshold. In this case, a representative  
fact is automatically selected by the system and  
20 displayed. In this embodiment, a method of generating  
view tables for fact in order of accumulation on the  
knowledge base to select facts in order of the tables is  
described.

A new view table 1717 for fact is allocated so  
25 that the pointer 1716 from the case order table is  
connected to the view table 1717. The verbal concept  
"graduate" is stored in an area 1704 corresponding to the  
case order table 1703. Then, in step 5765, the display/

1 not-display flag in the view table 1717 for fact is  
turned to "display". In step 5770, the number 1707 of  
facts expressed by the same verbal concept is added,  
whereafter the situation of the routine goes back to the  
5 step 5710.

The pointer 1725 to the next view table for  
fact is then traced to detect in step 5720 whether the  
verbal concept "graduate" 1727 in the view table 1726 for  
fact overlaps the verbal concept in the case order table  
10 allocated currently. Because the two concepts overlap  
each other, the situation of the routine goes to step  
5770. In the step 5770, the number 1707 of facts in a  
corresponding case order table is added, whereafter the  
situation of the routine goes back to the step 5710.

15 In this embodiment, the number of verbal facts  
is larger than the threshold. Accordingly, facts in the  
view table 1717 connected to the case order table 1703  
for the concept "graduate" are selected.

The pointer 1728 to the next view table for  
20 fact is further traced to detect in step 5720 whether the  
verbal concept "take" 1730 in the view table 1729 over-  
laps the verbal concept in the case order table allocated  
currently. Because the verbal concept in the case order  
table is only "graduate" 1704, the situation of the  
25 routine goes to step 5760. In the step 5760, a new case  
order table 1708 is allocated, so that the verbal concept  
"take" 1730 in the view table 1729 for fact is stored in  
the case order table 1708. Further, in the step 5760,

1 the display/not-display flag is turned to "display" and,  
in the step 5770, the number 1712 of facts is added.  
Further, a new view table 1720 for fact is allocated so  
that fact information is stored therein. The pointer  
5 from the case order table 1719 is connected to the view  
table 1720 for fact. Further, case order tables are  
connected by the forward and backward pointers 1705 and  
1706. This procedure is repeated to generate case order  
tables and view tables for fact for initial display.

10 Here, the number of facts expressed by the same  
verbal concept is as follows. The number of facts  
expressed by "graduate" is 3. The number of facts  
expressed by "take" is 2. The number of facts expressed  
by "build" is 19. Further, the last view table 1717 for  
15 fact for initial window in one verbal concept is con-  
nected to the case order table in the next verbal concept  
by the pointer 1718. Facts to be displayed are thus  
classified into groups and selected.

As another selection method, verbal concepts  
20 may be selected in the order of the number of facts  
registered with respect to the verbal concepts, in the  
order of frequency in use for reference or in the  
alphabetical order of name for verbal concepts. Facts  
classified by the same verbal concept may be selected in  
25 the order of importance of cases registered, in the order  
of the number of concepts registered in the cases, the  
order of frequency in use for reference or in the  
alphabetical order of name for concepts.

1           After facts to be displayed are selected as  
described above, in step 5780, number temporarily  
effective in the fact window is given to each fact. For  
example, the facts are numbered so that number "1" is  
5   given to the fact selected by "graduate" 1704 and that  
number "4" obtained by adding the number (three) of facts  
expressed by "graduate" 1704 thereto is given to the fact  
selected by "get" 1709.

Verbal facts are displayed in the verbal fact  
10   area in the form of a sentence and, on the other hand,  
attribute facts in which is-a relation, part-whole  
relation and the concept are registered as attribute  
object case and attribute facts in which the concept is  
registered as attribute value case are successively  
15   displayed in tabular form in the attribute fact area.

Initially, in step 5540 (see Fig. 55),  
information of super concepts with respect to the concept  
"Taro Hitachi" is extracted. Specifically, the pointer  
901 (see Fig. 9) from the node management table to the  
20   concept table for the concept "Taro Hitachi" and the  
pointer 908 to the super-concept table are traced on the  
basis of the node ID data for the concept to thereby  
refer to the concept ID data 910 in the table 909. Then,  
the case management table 1802 is allocated so that the  
25   pointer 1801 from the fact window table is connected to  
the case management table 1802. A flag "is-a" expressing  
is-a relation, instead of the case, is stored in the case  
area 1803. Then, the view table 1805 for fact is allo-

1 cated so that the pointer 1804 from the case management  
table is connected thereto. The view table for fact  
comprises attribute concepts, and other case slot fillers  
for attribute facts and so on. The is-a relation is a  
5 linkage relation which is different from the attribute  
concept as a node. Accordingly, "subconcept-of" (or  
"is-a") 1806 expressing a super-concept item name and  
"person" 1807 which is a super concept are stored in the  
attribute concept area and the area of the concept  
10 expressing the other attribute case, i.e., the attribute  
value case, respectively.

Then, in step 5575, a judgment is made as to  
whether there is any whole-concept. When there is some  
whole-concept, in step 5550, a data for displaying a fact  
15 is extracted from the list of binary trees in the same  
manner as in the is-a relation. The item name used  
herein is "part-of". In this embodiment, there is no  
whole-concept in the knowledge base with respect to the  
concept "Taro Hitachi". Accordingly, the situation of  
20 the routine goes to step 5555.

In this step, a case as a head data in the case  
priority list for attribute concepts is obtained. The  
data is attribute object case. Because the pointer of  
the list is not NULL, the situation of the routine goes  
25 to step 5560. A judgment is made as to whether there is  
any attribute fact in which "Taro Hitachi" is registered  
as attribute object case. Because there is some fact,  
the situation of the routine goes to step 5800. In step



1 5810 (see Fig. 58), the case management table 1909 is  
allocated so that the pointer 1908 from the case  
management table for is-a relations is connected to the  
case management table. Further, counters corresponding  
5 to the number of facts registered as attribute object  
case in the case area 1910 are initialized and then the  
situation of the routine goes to step 5825.

In this step, a list of binary trees of fact ID  
data for facts in which the concept is registered as the  
10 case is generated in the same manner as in the verbal  
facts. When there is some fact ID data overlapping  
between the list of fact ID data for the next attribute  
fact and the list of binary trees, the overlapping fact  
ID data is excluded in step 5835 and added to the list of  
15 fact ID data for the fact to be displayed in step 5840.  
In step 5845, the number of retrieved facts is added to  
the counter expressing the number of attribute facts and  
then the situation of the routine goes to step 5850. As  
described above, there is however no part-concept with  
20 respect to "Taro Hitachi". Accordingly, the situation of  
the routine goes to step 5880.

Then, in step 5885, attribute concept infor-  
mation, template ID, fact ID and so on are stored in a  
corresponding view table for fact on the basis of the  
25 list of binary trees, whereafter the situation of the  
routine goes back to the step 5880.

After the view table for fact with respect to  
the attribute object case is thus generated, the situa-

1 tion of the routine goes back to the step 5520 in which  
the table with respect to the attribute value case is  
generated.

Then, the situation of the routine goes to step  
5 5570 in which the number of attribute facts is stored in  
the fact window table. The structure of data thus  
generated is shown in Fig. 19.

Then, the situation of the routine goes back to  
the step 5700 again (see Fig. 57). In the step 5700, the  
10 view tables for fact are classified into groups by  
attribute concepts to reconstruct the list. The struc-  
ture of data classified into groups by attribute concepts  
is shown in Fig. 20. In Fig. 20, the number of facts to  
be displayed is smaller than the threshold. Accordingly,  
15 all view tables for fact are allocated newly.

Then, view position information is generated.  
Specifically, information concerning the view position of  
facts and super- or whole-concepts temporarily numbered  
in the step 5700 is generated in steps 5900 and 6200. As  
20 a result, not only the position pointed by a pointing  
device can be detected in the fact window area but the  
area can be displayed reversally.

With respect to verbal facts, after the view  
position information is initialized in step 5910 (see  
25 Fig. 59), the pointer of the fact window table and the  
pointer of the case management table are traced to refer  
to patterns corresponding to the template ID in the head  
table in step 5940. In the active pattern (see Fig. 11)

1 with respect to "take" classified in the case order table  
for agent case, as described above, agent case 1162, the  
verbal concept 1182, object case 1172, collection-in case  
1177 and time case 1167 are stored in order.

5           The case where view position information for  
the fact ID 85 is generated will be described as an  
example. As described above (see Fig. 12), it is now  
assumed that "Taro Hitachi", "doctorate", "1975" and  
"University B" are registered in agent case, object case,  
10 time case and collection-in case, respectively. The view  
table 2106 for case is allocated (see Fig. 21) so that  
the pointer from the view table 2104 for fact is con-  
nected thereto. Further, view tables 2107 for concept  
given correspondingly to the number of the case filled  
15 concepts are generated so that the pointer 2108 from the  
view table 2106 for case is connected thereto. In the  
fact, "Taro Hitachi" is a concept expressing agent case  
and is stored in the view table for concept for agent  
case, whereafter the situation of the routine goes to  
20 step 6000 (see Fig. 60).

          When the pattern is referred to in step 6020  
for setting the view position of the fact ID 85 for  
"take", the initial case is an agent case and the  
situation of the routine goes to step 6100 (see Fig. 61).  
25 In step 6110, a judgment is made as to whether there is  
any string of characters for preposition in the case.  
Because there is no string of characters, the situation  
of the routine goes to step 6125.

1           In this step, a judgment is made as to whether there are a plurality of case slot fillers. Because the case slot filler is only "Taro Hitachi" 1232 (see Fig. 12), the situation of the routine goes to step 6065.

5   After the view area of "Taro Hitachi" is set, the value of the width of the sentence is updated in step 6170. The view area is set by the width of the string of characters and the height thereof (unit: dots) as represented by the expression:

10           [X1, Y1, H1, W1]

in which X1 represents the X coordinate of the left end of the rectangular character area for the string of characters "Taro Hitachi", Y1 represents the Y coordinate of the upper left thereof, H1 represents the height of the character area, and W1 represents the width. The values of X1 and Y1 show the fact start coordinates calculated on the basis of the view area of a temporary number given to the fact to be displayed.

Then, the situation of the routine goes to step 20 6175 in which a judgment is made as to whether there is any string of characters for postposition in the case. Because the string of characters is "ga" 1164 (see Fig. 11), the situation of the routine goes to step 6180. In this step, the view area of postposition is set in the 25 same manner as the procedure of from the step 6165 to the step 6170, whereafter the situation of the routine goes back to the step 6010.

The view area of the string of characters in

1 time case or the like is calculated on the basis of the  
coordinates, the width of the string of characters and  
the height thereof in the same manner as described above.

When there are a plurality of case slot fillers  
5 as shown in Fig. 13, that is, when a set of concepts is  
registered, a string of characters "SET" is put in the  
left of the string of characters for the set of concepts  
and then the string of characters including "SET" and the  
set of concepts is enclosed in parentheses to make the  
10 range of the set of concepts obvious (see Fig. 7). Not  
only the view areas of respective concepts in the set of  
concepts are set in the procedure of from step 6140 to  
step 6150 but the view area of the set of concepts as a  
whole is set in step 6155, so that relational information  
15 can be obtained even if the set of concepts is regarded  
as one concept.

When the case slot filler is an indefinite  
concept, "?" is put in the right of the string of  
characters for the concept. For example, the fact

20 "Taro Hitachi and Yoshio Tanaka or else set up  
office" is expressed as follows.

(SET: Taro Hitachi ; Yoshio Tanaka ?)

With respect to other cases, view tables for  
case and view tables for concept are generated  
25 successively in the same manner as described above.

When the data to be displayed in the step 6020  
(see Fig. 60) is a verbal concept, the situation of the  
routine goes to step 6030. The verbal concept is

1 accompanied with tense information. Accordingly, a  
string of characters for the verb is generated on the  
basis of voice and tense information. Because the verb  
is "active" and "past", "took" 1014 is obtained by  
5 referring to the voice and tense name table (see Fig.  
10). Then, the view area of the string of characters is  
set in steps 6030 and 6040.

The maximum width of the sentence is updated in  
the procedure of from step 6060 to step 6080 so that one  
10 fact can be displayed in one line.

A verbal fact is expressed in the form of a  
sentence and, on the other hand, an attribute fact is  
expressed in the form of a table. Specifically, an  
attribute fact expressed by a concept is constituted, as  
15 attribute items, by

- 1) is-a relation,
- 2) part-whole relation,
- 3) attribute concept,

and constituted, as concept items, by

- 20 4) super-concept,
- 5) whole-concept,
- 6) other case slot filler for fact.

Accordingly, the attribute fact is different from the  
verbal fact in that the attribute fact requires no  
25 preposition/postposition. However, an attribute item  
area and a concept item area must be set preliminarily.

After the view position information is  
initialized in step 6210 (see Fig. 62), the pointer of

1 the view table for fact and the pointer of the case  
management table are traced successively to generate a  
string of characters for attribute item on the basis of  
information such as attribute concept ID stored in the  
5 view table for fact and measure the view width of the  
string of characters in step 6225. Then, in step 6230,  
the coordinates of the view start point of the string of  
characters are set.

In this embodiment, the view width of  
10 "subconcept-of" (or "is-a") 2015 which is an item name  
for is-a relation is measured. Then, the pointer 2005 of  
the case management table is traced (see Fig. 20) to  
generate an item name on the basis of the attribute  
concept of an attribute registered as an attribute object  
15 case. However, the attribute fact is not accompanied  
with any preposition/postposition, so that the sense of  
the case cannot be understood easily. Therefore, a  
string of characters for the attribute concept of a fact  
registered as an attribute object case is enclosed by ">"  
20 to generate a new string of characters and set the  
coordinates of the view start point. When, for example,  
the attribute concept is "nationality" 2019, the string  
of characters is expressed as ">nationality>" or simply  
"nationality". Then, the view width of the string of  
25 characters is measured and then the situation of the  
routine goes back to the step 6220. The string of  
characters for the attribute object case is generated  
thus to measure the view width thereof.

1           Further, the pointer 2009 of the case manage-  
ment table is traced to generate an item name on the  
basis of the attribute concept for an attribute regis-  
tered as an attribute value case. To show that the  
5 attribute value case and the attribute object case are  
relative to each other, a string of characters obtained  
by putting "of" in the right of the string of characters  
for the attribute concept is regarded as an attribute  
item name and then the view width of the string of  
10 characters is measured. The maximum view width of the  
attribute item is thus set and stored separately in step  
6235.

Then, the situation of the routine goes to step  
6240. In step 6250, the pointer of the case management  
15 table is traced to set the view area of the concept item  
in the same manner as in the attribute item. The string  
of characters for the concept "person" 2016 which is a  
super-concept with respect to "Taro Hitachi" stored in  
the view table for fact is regarded as a view string of  
20 characters and then the width thereof is measured.  
Further, the coordinates of the upper left of the  
rectangular form in the view area of the concept item are  
calculated on the basis of the view width of the attri-  
bute item and set. Then, the situation of the routine  
25 goes back to the step 6245.

Then, the pointer 2005 of the case management  
table is traced so that the concept of the attribute  
value case which is the other case defined by an attri-



1 bute with respect to the attribute registered as an  
attribute object case is given as an item name to measure  
the width of the string of characters. For example,  
the concept "Japan" corresponds to the view item  
5 ">nationality>" (or "nationality"). Further, the  
coordinates of the upper left of the view area are set.  
The same procedure as described above is applied to the  
attribute value case. Thus, the maximum view width of  
the concept item is set and stored separately.

10 When there are a plurality of super- or whole-  
concepts or when a set of concepts is registered in the  
other case for attribute, the view area is set while  
regarding the number of concepts as the number of display  
lines.

15 After the view positions of verbal facts and  
attribute facts are set as described above, the facts are  
displayed according to the position information in step  
5450. In Fig. 7, "subconcept-of" (or "is-a") 712 in the  
area of the attribute item name and "person" 713 in the  
20 area of the concept item name are displayed as super-  
concept information with respect to "Taro Hitachi" in the  
attribute view area. In the fact "nationality of Taro  
Hitachi is Japan" in which "Taro Hitachi" is registered  
as an attribute object case, ">nationality>" (or  
25 "nationality") 714 and "Japan" 715 are displayed in the  
area of the attribute item name and the area of the  
concept item name, respectively. In the fact "Taro  
Hitachi is designer of Katagiri house" in which "Taro

1   Hitachi" is registered as an attribute value case,  
      "<designer<" (or "designer-of") 718 and "Katagiri's  
      residence" 719 are displayed.

                  Displaying of verbal facts expressed by  
5   concepts and displaying of is-a relation, part-whole  
      relation and attribute facts can be performed on the  
      basis of the view position information set as described  
      above.

                  In the following, the display of fact infor-  
10   mation for verbal concepts will be described as a second  
      embodiment according to the display method of the  
      invention.

                  The fact information is displayed by clicking a  
      verbal concept in a concept tree through a mouse and  
15   selecting a menu from a list of functions expressed as a  
      pop-up menu in the same manner as in the display of a  
      view window for fact with respect to concepts. Fig. 29  
      shows an interactive display at browsing. The verbal  
      concept "take" 2901 displayed in the node tree is clicked  
20   through a mouse and the procedure of from the step 5310  
      to the step 5350 is carried out in the same manner as in  
      the method for displaying fact information for concept  
      (see Fig. 53), whereafter the situation of the routine  
      goes to step 6300. The view window 2902 for fact with  
25   respect to "take" is displayed according to the display  
      data generated. The method for displaying fact infor-  
      mation for verbal concepts is similar to the method for  
      displaying the view window (see Fig. 7) for fact with

1 respect to concepts in the verbal area, except the method  
of referring to verbal facts. The method of referring to  
verbal facts will be described below.

In step 6310 (see Fig. 63), a list of fact ID  
5 data to be displayed and a counter expressing the total  
number of verbal facts are initialized. Then, in step  
6320, a judgment is made as to whether there is any  
verbal fact registered with respect to the verbal concept  
"take". When there is some verbal fact, in step 6330, a  
10 list of binary trees is generated so that fact ID data  
are stored therein. Further, the case management table  
is allocated so that the pointer from the view window  
table for fact is connected thereto.

In step 6345, the view table for fact is  
15 allocated so that the pointer from the case management  
table is connected thereto on the basis of the list of  
binary trees of fact ID data. In step 6350, fact ID,  
template ID, verbal concept information and tense  
information are stored by successively referring to the  
20 fact information. In step 6355, the case order table is  
allocated so that the pointer from the case management  
table is connected thereto. Then, in step 6360, number  
temporarily used in the view window for fact is given,  
whereafter the situation of the routine goes back to the  
25 step 6340.

In this embodiment, data to be displayed are  
generated by successively referring facts in the order of  
accumulation on the knowledge base. Accordingly, there

1 is no sorting on the basis of case priority. Therefore,  
the view table for fact designated by the case management  
table coincides with the view table for fact designated  
by the case order table. As another method, sorting may  
5 be performed in the order of importance of the cases  
registered, in the order of frequency in use for refer-  
ence or in the alphabetical order of name for case slot  
fillers.

Fig. 30 shows a view window for fact in which  
10 facts expressed by "take" are sorted in the order of the  
number of cases. The fact "Taro Hitachi took doctorate  
at University B in 1975" 3001 corresponding to the number  
"1" is expressed by four cases, namely, the concept "Taro  
Hitachi" expressed by agent case, the concept "1975"  
15 expressed by time case, the concept "doctorate" expressed  
by object case and the concept "University B" expressed  
by collection-in case. The next fact "Taro Hitachi took  
bachelor of engineering in 1970" 3002 is expressed by  
three cases. Each of the fact "Yoshio Tanaka took  
20 license of architect" 3003 and the following facts is  
expressed by two cases. Facts may be displayed by such  
sorting method.

The setting of view areas for respective  
strings of characters in the window is performed in the  
25 same manner as the setting of the verbal area in the view  
window for fact with respect to concepts.

The view window for fact with respect to verbal  
concepts is displayed on the basis of the display data

1   thus generated.

          The display of fact information for verbal  
concepts can be performed as described above.

          In the following, the display of fact infor-  
5   mation for attribute concepts will be described as a  
third embodiment according to the display method of the  
invention.

          The fact information is displayed by clicking a  
mouse in an attribute concept in a node tree and select-  
10   ing a desired item from a list of functions expressed as  
a pop-up menu in the same manner as in the display of  
fact information for concepts. Fig. 31 shows an inter-  
active display at browsing. The attribute concept  
"nationality" 3101 displayed in the node tree is selected  
15   by clicking the mouse and the procedure of from the step  
5310 to the step 5350 is carried out in the same manner  
as in the method for displaying fact information for  
concepts (see Fig. 53), whereafter the situation of the  
routine goes to step 6300. The view window 3102 for fact  
20   with respect to "nationality" is displayed according to  
the display data thus generated.

          The method for displaying the window is similar  
to the method for displaying the view window for fact  
with respect to concepts in the attribute area, except  
25   the method of referring to attribute facts and the method  
of generating strings of characters to be displayed in  
respective lines.

          The method of referring to facts will be

1 described below. In step 6410 (see Fig. 64), a list of  
fact ID data for facts to be displayed and a counter  
expressing the total number of facts are initialized.  
Then, in step 6420, a judgment is made as to whether  
5 there is any attribute fact registered with respect to  
the attribute concept "nationality". When there is some  
fact, a list of binary trees is generated in step 6430 so  
that fact ID data are stored therein. Further, the case  
management table is allocated so that the pointer from  
10 the view window table for fact is connected thereto.

In step 6445, the view table for fact is  
allocated on the basis of the list of binary trees of  
fact ID data, so that the pointer from the case manage-  
ment table is connected thereto. In step 6450, fact ID,  
15 template ID, attribute concept information and tense  
information are stored by referring to the fact informa-  
tion. Then, in step 6455, case order tables are allo-  
cated so that the pointer from the case management table  
is connected thereto. Then, in step 6460, numbers  
20 temporarily used in the view window for fact are respec-  
tively given to the facts, whereafter the situation of  
the routine goes back to the step 6440.

In this embodiment, data to be displayed are  
generated by successively referring facts in the order of  
25 accumulation on the knowledge base. Accordingly, there  
is no sorting. As another method, sorting of facts may  
be performed in the order of the number of concepts  
expressing attribute object case or attribute value case,

- 1 in the order of frequency in use for reference or in the alphabetical order of name for concepts.

The method of generating strings of characters to be generated will be described below.

- 5 In the display of fact information in the form of a table, the fact window for concepts is generated so that attribute item name and concept item name are respectively arranged in the first and second columns. On the contrary, the fact window for attribute concepts  
10 is generated so that concept name registered as attribute object case and concept name registered as attribute value case are respectively arranged in the first and second columns.

- In step 6510 (see Fig. 65), position information for data to be displayed is initialized. Then, in  
15 the procedure of from step 6510 to step 6530, the width and height of the character string with respect to concepts expressing attribute object case are measured to set the coordinates of the view start point. Then, in  
20 step 6535, the width of the first column, that is, the width of the column of concepts expressing attribute object case, is stored. Then, in the procedure of from step 6540 to step 6550, the view area for concepts expressing attribute object case is set and, at the same  
25 time, the width and height of the character string is measured to set the view area. Thus, data to be displayed are generated.

Fig. 32 shows a fact window in which facts

1 expressed by the attribute concept "nationality" are  
sorted by attribute value case. In this drawing, the  
fact "nationality of Taro Hitachi is Japan" is expressed  
by respectively displaying "Taro Hitachi" 3201 and  
5 "Japan" 3205 in the first and second columns of No. "1"  
line. Like this, "Yoshio Tanaka" 3202 and "Reiko Sagawa"  
3203 are displayed with the fact that the nationality  
thereof is "Japan" 3206, 3207. The concept expressing  
attribute value case in No. "5" is "United States" 3208,  
10 so that other national names than "Japan" are considered  
to be arranged after this line. Facts may be displayed  
by such sorting method.

The setting of view areas for respective  
strings of characters in the window is performed in the  
15 same manner as the setting of attribute areas in the fact  
window for concepts.

The fact window for attribute concepts is  
displayed on the basis of the display data thus  
generated.

20 The display of fact information for attribute  
concepts can be performed as described above.

In the following, the additional display of  
fact information not displayed in the fact window for  
concepts in which fact information automatically selected  
25 by the system has been displayed will be described as a  
fourth embodiment according to the display method of the  
invention.

An item is selected from a list of functions



1 displayed as a pop-up menu by clicking a mouse in a  
number area in the window, so that facts expressed by the  
same verbal concept as a fact corresponding to the number  
selected are displayed in a same relation window. Fig.  
5 33 shows an interactive display at browsing.

A view table for fact in which the view area  
including the position pointed by clicking the mouse is  
set is retrieved by detecting the position pointed by  
clicking the mouse and tracing the pointer from the fact  
10 window table. After the retrieval of the table, a case  
management table and a case order table connected to the  
table by the pointer are retrieved.

For example, the display of the same relation  
from the fact window 3301 for "Taro Hitachi" in Fig. 33  
15 is performed as follows. When the number "4" 3302 is  
selected by clicking the mouse, a display area corre-  
sponding to the number "4" is retrieved by tracing the  
pointer from the fact window table. As a result, a view  
table 2104 for fact (see Fig. 21) corresponding to the  
20 fact "Taro Hitachi took doctorate at University B in  
1975" identified by the number is detected. With respect  
to the case management table, a case management table  
2101 for agent case is selected. Because "Taro Hitachi"  
in the fact is a concept expressing agent case, the  
25 pointer from the case management table for agent case to  
the view table for fact is traced to judge whether there  
is any fact expressed by "take" except this fact in fact  
view tables which have been generated for displaying

1 facts. Because the view table 2102 for fact having the  
fact ID of 171 is fitted now, fact information is  
referred to on the basis of the fact ID.

View data with respect to the fact "Taro  
5 Hitachi took doctorate at University B in 1975" which has  
been displayed in the fact window and the fact "Taro  
Hitachi took bachelor of engineering at University A in  
1970" which has been not displayed are generated so that  
the same relation window is displayed. Fig. 34 shows an  
10 initial state of the same relation window for "take"  
registered with "Taro Hitachi" as a concept expressing  
agent case. A button 3401 in the left of the fact "Taro  
Hitachi took doctorate at University B in 1975" 3403  
indicates that the fact is in a display state in the fact  
15 window. A button 3402 in the left of the fact "Taro  
Hitachi took bachelor of engineering at University A in  
1970" indicates that the fact is in a not-display state.

As another means for indicating the display/  
not-display state, a means for indicating the state by  
20 icon, a means for indicating the state by changing the  
view condition of the number, or the like, may be  
employed.

A fact to be additionally displayed can be  
selected by clicking a button in the same relation window  
25 through the mouse. Fig. 35 shows the same relation  
window displayed when the button 3501 in the left of the  
fact "Taro Hitachi took bachelor of engineering at  
University A in 1970" is selected.

1                   When a desired item is selected from the menu  
by judging a fact from the position pointed by clicking  
the mouse, view data for the fact to be additionally  
displayed are generated. Specifically, the case  
5 management table and the case order table are traced so  
that a new view table 2204 for fact is allocated to  
follow the view table 2202 which has been already  
allocated and that the pointer 2203 from the last view  
table for fact is connected thereto (see Fig. 22). After  
10 fact information to be added is stored in the view table  
for fact, view tables for concept are allocated in the  
order of the view pattern so that the pointer 2205 from  
the view table for fact is connected thereto. A list of  
binary trees of case slot fillers 2206 and 2207 is  
15 allocated so that concept information expressing the case  
is stored therein. Further, the display/not-display flag  
turned to "display" is stored.

Then, view position information for verbal  
facts is reconstructed so that the fact "Taro Hitachi  
20 took bachelor of engineering at University A in 1970" to  
be additionally displayed can be displayed in the next  
line just under the currently displayed fact "Taro  
Hitachi took doctorate at University B in 1975" expressed  
by the same verbal concept. For example, the Y coordi-  
25 nate of the fact 3606 identified by the number "6" 3603  
is replaced by the Y coordinate of the fact displayed one  
line below (see Fig. 36).

The fact window is re-displayed on the basis of

1 the view position information thus reconstructed. Fig.  
36 shows the fact window which is displayed additionally.  
The fact window is re-displayed so that the fact to be  
inserted in the fact window is displayed just under the  
5 fact identified by the number "4" 3601 after the number  
"5" 3602 is given to the fact to be inserted and that  
facts which have been described are successively moved  
down by one line. The additional display of fact  
information can be performed as described above.

10 In the following, the display of the fact  
window for concept and subconcept will be described as a  
fifth embodiment according to the display method of the  
invention.

The window used herein is a fact window for a  
15 concept containing a subconcept among concepts registered  
in the knowledge base. The window is displayed by  
clicking a concept in a concept tree through a mouse and  
selecting a desired item from a list of functions dis-  
played as a pop-up menu. Fig. 37 shows the fact window  
20 for concept and subconcept.

In the procedure of from step 5620 to step 5645  
(see Fig. 56), a list of fact ID data for verbal facts  
expressed by the concept "person" is generated. In the  
procedure of from step 5650 to step 5675, a list of fact  
25 ID data for verbal facts relative to subconcepts of the  
concept "person" is generated. The method for grouping  
facts by relational concepts, the method for selecting  
the display/not-display state and the method for gene-

1 rating view data for verbal facts are similar to those  
used for concepts containing no subconcept.

Then, in the procedure from step 5820 to step  
5845 (see Fig. 58), a list of fact ID data for attribute  
5 facts expressed by the concept "person" is generated. In  
the procedure of from step 5850 to step 5875, a list of  
fact ID data for attribute facts expressed by subconcepts  
of the concept "person" is generated. The method for  
storing fact information is similar to that used for  
10 concepts containing no subconcept. Then, in step 5450,  
facts expressed by the concept "person" and subconcepts  
thereof are displayed in the fact window on the basis of  
view data in the same manner as in the fact window for  
concepts containing no subconcept.

15 With respect to the attribute fact area, facts  
expressed by super- or whole-concepts of the concept  
"person", the concept "person" registered as attribute  
object and attribute value cases and sub- or part-  
concepts thereof are displayed.

20 The fact window for "person" is displayed on  
the basis of the view data thus generated. In Fig. 37,  
"Yoshio Tanaka" 3701 and "Taro Hitachi" are subconcepts  
of "person", so that the fact window for attribute  
concept is displayed by selecting facts having the  
25 subconcepts registered.

With respect to attribute facts expressed by  
subconcepts, ellipses "..." 3703 and the like are  
displayed because the contents of the facts cannot be

1 perfectly expressed by the attribute item and the concept  
item. The fact window for attribute concepts is displayed by clicking a string of characters in the attribute item through a mouse and selecting a desired item  
5 from a list of functions displayed as a pop-up menu.

A method using a table composed of three items consisting of an item for registered concepts, an attribute item and an item for concepts registered in another case to display the table in the attribute fact  
10 area may be used as another method.

The display of fact information for concepts and subconcepts can be performed as described above.

In the following, the browsing of concepts and subconcepts displayed in the fact window will be  
15 described as a sixth embodiment according to the display method of the invention.

A fact window corresponding to a concept pointed by a mouse is displayed by selecting a desired item from a list of functions displayed as a pop-up menu  
20 through clicking the mouse in one of concepts displayed in the fact window for concept, in the fact window for verbal concept or in the fact window for attribute concept.

Fig. 38 shows a display in which a concept  
25 "Taro Hitachi" is pointed in a fact window for a verbal concept "take". Fig. 39 shows a display in which a concept "Taro Hitachi" is pointed in a fact window for an attribute concept "nationality". In Fig. 38, a concept

1 "Taro Hitachi" 3802 is pointed in a fact window 3801 for  
"take". In Fig. 39, a concept "Taro Hitachi" 3902 is  
pointed in a fact window 3901 for "nationality". In each  
of Figs. 38 and 39, a fact window 3803, 3903 for "Taro  
5 Hitachi" is displayed. Fig. 40 shows a display in which  
a concept "Japan" 4002 is pointed in a fact window 4001  
for a concept "Taro Hitachi". In Fig. 40, a fact window  
4003 for "Japan" is further displayed.

A fact window for a desired verbal concept is  
10 displayed by selecting an item from a list of functions  
displayed as a pop-up menu through clicking a mouse in a  
verbal concept displayed in a verbal fact area in a fact  
window for concept or in a fact window for verbal con-  
cept. When, for example, a verbal concept "graduate"  
15 3804 is pointed in a fact window 3803 for a concept "Taro  
Hitachi" in Fig. 38, a fact window for "graduate" can be  
displayed.

A fact window for a desired attribute concept  
is displayed by selecting an item from a list of func-  
20 tions displayed as a pop-up menu through clicking a mouse  
in an attribute concept displayed in an attribute fact  
area in a fact window for concept. That is, Fig. 39 also  
shows a display in which an attribute concept  
"nationality" 3904 is pointed in a fact window 3903 for a  
25 concept "Taro Hitachi".

The verbal fact area and attribute fact area in  
the fact window for concept, the view area in the fact  
window for verbal concept and the view area in the fact

1 window for attribute concept have view areas for strings  
of characters displayed, respectively. Accordingly, a  
concept or a relational concept displayed in a view area  
can be detected by retrieving the view area containing a  
5 position pointed by clicking a mouse, in the same manner  
as in the case where a concept or a relational concept is  
pointed from a node tree by clicking a mouse. The kind  
of the concept or relational concept thus detected is  
judged to inquire of the window management table whether  
10 there is any fact window for the concept or relational  
concept. When some fact window has been already  
displayed, a message is displayed in the same manner as  
in the step 5460. When there is no fact window dis-  
played, view data are generated correspondingly to the  
15 judgment in the same manner as in the procedure following  
after the step 5420. When the kind is judged to be a  
concept, a fact window for the concept is displayed on  
the basis of the view data. When the kind is judged to  
be a verbal concept, a fact window for the verbal concept  
20 is displayed on the basis of the view data. When the  
kind is judged to be an attribute concept, a fact window  
for the attribute concept is displayed on the basis of  
the view data. The method of generating the view data is  
based on the method in the fact window.

25 After the window management table is allocated,  
information in a fact window displayed newly is stored in  
the table and managed therein.

The browsing of concepts and relational



1 concepts displayed in a fact window can be performed as described above.

In the following, the full-sentence display of facts displayed in a fact window for a concept will be  
5 described as a seventh embodiment according to the display method of the invention.

The full sentence of a fact identified by a number is displayed in a fact window in a sentence by selecting an item from a list of functions displayed as a  
10 pop-up menu through clicking a mouse in a number area in a fact window for a concept. Fig. 41 shows a display in which the full sentence of a fact is displayed in a fact window for a concept "Taro Hitachi".

A view table for fact in which a view area  
15 including a position pointed by clicking a mouse is set is retrieved by tracing the pointer from the fact window table through detecting the position pointed by clicking the mouse. At the same time, a case management table and a case order table connected to the view table for fact  
20 containing the view area by the pointer are retrieved.

The full sentence of a fact selected from a fact window for a concept "Taro Hitachi" in Fig. 41 is displayed as follows. When a temporary number "4" 4101 is pointed by clicking a mouse, the selected fact "Taro  
25 Hitachi took doctorate at University B in 1975" is detected in the same manner as in the same relation window.

In the full-sentence display, the view area and

- 1 the view position of the fact window in a sentence are  
limited so that the full sentence can be disposed in a  
suitable place on a display. In this point, the full-  
sentence display is different from the display of verbal  
5 facts.

Information concerning prepositions, case slot fillers and postpositions stored in a view table for concept is referred to by tracing the pointer of the view table for a selected fact. In Fig. 20, the width of a  
10 string of characters "Taro Hitachi" in agent case which is the first case is measured. The maximum width of the view area preliminarily set is considered as surplus width, so that the width of the string of characters is compared with the surplus width. When the width is  
15 smaller than the maximum width, the view area is set so that the string of characters in agent case is put in the head of the first line. At the same time, the surplus width is updated to be a value obtained by subtracting the width of the string of characters from the maximum  
20 width. Then, information concerning a preposition, a case slot filler and a postposition in the time case is referred to. The width the string of characters for the concept "1975" is compared with the surplus width to set the view area. The respective widths of the strings of  
25 characters in object case and collection-in case are successively compared with the current marginal width in the same manner as described above.

In the fact, the width of the string of

1 characters "at University B" 3403 in collection-in case  
is larger than the surplus width. Accordingly, the first  
line is finished at object case (with respect to which  
the view position has been already determined) just prior  
5 to collection-in case, that is, a new line is begun at  
collection-in case to set the view area.

When a set of concepts (set concepts), that is,  
a plurality of concepts, are registered in one case, the  
following three methods are used for generating strings  
10 of characters to be displayed.

The first method is applied to the case where  
the width of a combination of a preposition, a string of  
characters "SET" expressing the start of a set of  
concepts and the first concept thereof, or the width of a  
15 combination of a preposition, a string of characters  
"SET" expressing the start of a set of concepts, the  
first concept thereof and a concept delimiter mark is  
larger than the surplus width, or to the case where the  
width of a combination of the last concept in a set of  
20 concepts and a character ")" expressing the end of the  
set of concepts is larger than the surplus width. In  
these cases, the view area is set so that a new line is  
begun.

The second method is applied to the case where  
25 the width of a combination of a preposition, a string of  
characters "SET" expressing a set of characters, the  
first concept thereof and a concept delimiter mark is not  
larger than the surplus width but the sum of the width of

1 the combination and the width of the second concept in  
the set of concepts is larger than the surplus width, or  
to the case where the width of a combination of the N-th  
concept in a set of concepts and a delimiter mark is not  
5 larger than the surplus width but the sum of the width of  
the combination and the width of the (N+1)-th concept is  
larger than the surplus width. In the former case, the  
view area is set so that a new line is begun at the  
second concept in the string of concepts. In the latter  
10 case, the view area is set so that a new line is begun at  
the (N+1)-th concept.

The third method is applied to the case where  
the width of a combination of concepts in a set of  
concepts and a character ")" expressing the end of the  
15 set of concepts is not larger than the surplus width but  
the sum of the width of the combination and the width of  
a postposition is larger than the surplus width. In this  
case, the view area is set so a new line is begun at the  
string of characters as a combination of the concepts,  
20 the characters ")" and the postposition.

After the area for displaying a string of  
characters as a combination of a preposition, a case slot  
filler and a postposition is set, the area for displaying  
a string of characters as a verbal concept is set. Thus,  
25 the respective strings of characters are displayed on the  
basis of the view areas in a fact window in a sentence.

The coordinates of the lower left of a number  
area are detected, so that a value obtained by adding a

1   predetermined value to the Y coordinate thereof is set as  
the Y coordinate of the starting point (upper left) of  
the fact window in a sentence. When the sum of the X  
coordinate thereof and the maximum value of the view area  
5   is not larger than the total width of the display, a  
value obtained by adding a predetermined value to the X  
coordinate thereof is set as the X coordinate of the  
starting point (upper left) of the window. When the  
coordinates of the lower right of the view area in the  
10 window thus set is out of range allowed for display, the  
coordinates of the starting point is reset so that the  
view area of the window is in the allowed range. The  
window obtained by setting the view area as described  
above is a fact window in a sentence in Fig. 41.

15               Thus, the display of the full sentence of a  
fact displayed in a fact window for a concept can be  
performed.

In the following, the display of a candidate  
for a query condition will be described as an eighth  
20 embodiment according to the display method of the  
invention.

Fig. 42 shows a group of windows for conver-  
sation with a user at the time of query editing. The  
concept selected by the user through clicking the left  
25 button of a mouse at the time of query editing is called  
"current concept". The current concept is displayed  
emphatically. In this embodiment, the current concept is  
emphasized by a rectangular form 4223. The sentence

- 1 forming a condition for retrieving a concept is called  
"query".

The basic window is classified into three,  
namely, super-concept window 4201, query editing window  
5 4211 and node tree window 4221. Among concepts from the  
uppermost concept "UNIVERSAL" 4203 in the knowledge base  
to the current concept, a group of super-concepts  
connected to the current concept by is-a relations are  
displayed in the super-concept window 4201.

- 10 A query is displayed in the query editing  
window 4211. The part enclosed by brackets in the window  
represents a case in which replacement is allowed. One  
of concepts enclosed by brackets is the current concept.  
The concept as a base for adding a query condition is  
15 called "root concept in a query".

A node tree for concepts allowed to be put in a  
case using the current concept in a query is displayed in  
the node tree window 4221 so that the current concept is  
arranged therein. The uppermost concept among case  
20 constraint concepts is called "anchor concept". The  
uppermost concept among concepts displayed in the window  
is called "root concept in a tree".

- The restriction addition window 4231 is popped  
up when a new restriction line is added to the query.
- 25 The window is displayed by user's selecting an item from  
a list of functions in a pop-up menu through clicking a  
mouse in a concept in the query.

In Fig. 42, the root concept in the query is

1 "company" 4213, and the conditions added to "company" are  
"Its place is [Tokyo]" 4217 and "it was established by  
[person]" 4219. Further, a condition (restriction) based  
on the relational concept "take" is to be added to the  
5 "person" by using the restriction addition window 4231.  
In the node tree window, a string of characters  
"intellectual entity" 4227 is displayed, and strings of  
characters "person" 4225 and "organization" as subcon-  
cepts thereof are displayed in suitable places. The is-a  
10 relations between "intellectual entity" and "person" and  
between "intellectual entity" and "organization" are  
expressed by connecting these concepts by line. The line  
4229 represents the is-a relation between "intellectual  
entity" and "person". In this case, the root concept in  
15 the tree is "intellectual entity" 4227.

In the query editing window 4211, "company"  
4213 is a root concept in a query. A concept enclosed in  
brackets in the query can be changed to the current  
concept by pointing a string of characters expressing the  
20 concept enclosed in the brackets through clicking a  
mouse. The node tree in the node tree window is dis-  
played so that a category allowed to be inputted in the  
case using the current concept in the query is put in the  
central place. Accordingly, when a concept except the  
25 current concept in the query editing widow is pointed as  
a new current concept, the node tree in the node tree  
window is automatically changed to a new node tree having  
the new current concept in the central place. In Fig.

1 42, the current concept "person" 4215 is used as agent  
case of a relational concept "establish". When  
"intellectual entity" is set as a case constraint concept  
of agent case in a template of "establish", the uppermost  
5 concept among concepts permitting the change of the  
current concept in the case, such as "intellectual  
entity", is the anchor concept. The anchor concept is  
displayed emphatically as "intellectual entity" 4207 in  
the super-concept window. Although Fig. 42 shows the  
10 case where the case constraint concept coincides with the  
anchor concept, the two do not always coincide with each  
other. In Fig. 43, the current concept is "person" 4310,  
which is restricted as follows.

"It graduated from [University A]" (4303)

15 The "person" is used as agent case of  
"graduate".

Accordingly, no concept but concept used as agent case of  
"graduate" can be put in agent case of "establish". The  
case constraint concept of agent case in the template of  
20 "graduate" is "person". Accordingly, the category of  
concepts permitting the change of the current concept is  
a common portion contained in subconcepts of "intel-  
lectual entity" and "person", that is, a set of subcon-  
cepts of "person". In this case, the anchor concept is  
25 "person", so that the super-concept window shows that  
"person" 4305 is an anchor concept.

When an anchor concept is given, the root  
concept in the tree is equal to the anchor concept. When



1 a plurality of anchor concepts are given, the root  
concept in the tree is equal to the lowermost concept  
among common super-concepts of the anchor concepts. Fig.  
44 shows the case where a plurality of anchor concepts  
5 are given. In the drawing, the current concept is  
"workstation" 4403. The current concept is used as  
object case of "develop". The case constraint concepts  
of object case of the template of "develop" are "hard-  
ware" and "software". Because there is no restriction  
10 given to the current concept, the anchor concepts are  
"hardware" and "software". The root concept in the tree  
is the lowermost concept "artificial thing" 4405 among  
super-concepts common to "hardware" and "software".  
Concepts subsumed under "artificial thing" are displayed  
15 in the node tree window.

Concepts subsumed under the anchor concept in  
the super-concept window, the query editing window and  
the node tree window are displayed by white-on-black  
characters as shown in this embodiment to distinguish the  
20 concepts from other concepts. Display in italic types,  
display in different fonts, display in different colors  
or display in pointers such as frames, underlines or the  
like may be used as another distinguishing method.  
Further, the current concept is displayed with another  
25 pointer, for example, in this embodiment, a rectangular  
form. As a result, the user can see at a glance what  
concept can be put in the case using the current concept  
in the query. Fig. 44 shows that "artificial thing" 4405

1 expressed by other characters than the white-on-black  
characters cannot be used in the case of "workstation"  
4403 used in the query sentence "It developed [work-  
station]" 4401 to substitute for "workstation" but other  
5 concepts expressed by white-on-black characters can be  
used.

The display of a candidate for a query condi-  
tion can be performed as described above.

In the following, the display of a verbal query  
10 and an attribute query allowed to be added will be  
described as a ninth embodiment according to the display  
method of the invention. The case where "Company placed  
in Tokyo and established by person who took doctorate at  
University A" is retrieved is used as an example.

15 When a query used for the previous retrieval  
remains in the query editing window, the query is  
initialized by selecting "reset" from the "display" menu  
in the window. As shown in Fig. 45, the root concept in  
the query in the query editing window is changed to  
20 "concept" 4511 and, at the same time, the root concept in  
the tree and the anchor concept are changed to "concept"  
4523. This is because objects of the retrieval are  
conceptual concepts, that is, concepts subsumed under  
"concept" (in the node tree). In this case, the object  
25 of the retrieval is "company". Accordingly, when  
"company" 4525 in the node tree window is pointed by  
clicking a mouse in step 6600, the root concept in the  
query is changed to

1           [Company] : ?

so that super-concepts of "company" are displayed in the  
super-concept window. When there is no restriction given  
to "company", the condition in step 6610 is not satisfied  
5 but the retrieval can be performed in step 6680. In this  
case, all companies registered in the knowledge base are  
retrieved. In the addition of a restriction, "new  
restriction addition" in step 6620 is fitted. When the  
root concept "company" in the query in the query editing  
10 window is pointed by clicking a mouse in step 6710, a  
list of functions allowed to be executed is displayed as  
a pop-up menu in step 6720.

When an item is selected from the list in step  
6730, the pointer to a list of relational template ID  
15 allowed to give a restriction to "company" is initialized  
to NULL and then a list of template ID is generated in  
step 6810. Then, in step 6820, a list of facts using the  
concept "company" is obtained from the knowledge base.  
Fig. 23 shows a fact using a concept named "company" 2301  
20 and the condition in which information of a template  
allowed to use the concept is stored. In this drawing,  
the part enclosed in double quotation marks, such as

"company" 2301,

represents that the enclosed information is a string of  
25 characters. Although this drawing shows the case where  
the string of characters such as "company" is directly  
held, the invention can be applied to the case where  
string ID instead of the string of characters is held so

- 1 that a table expressing the correspondence between string  
ID and the string of characters is provided separately.  
For simplification of description, this drawing shows the  
case where the string of characters is directly held.
- 5 This rule can be applied to all strings of characters  
enclosed in double quotation marks.

The list of ID for facts using a concept is  
held in each case. In Fig. 23, a fact identified by fact  
ID 2312 and a fact identified by fact ID 2314 use  
10 "company" as agent case. A fact identified by fact ID  
2322 and a fact identified by fact ID 2324 use "company"  
as recipient case. A list of these fact ID data is  
obtained.

When the pointer to the list of fact ID thus  
15 obtained is not NULL (step 6830), template ID of a  
relation used by the fact pointed by the pointer is  
obtained in step 6832. Information relative to the fact  
can be obtained from the fact ID 2401 pointed by the  
pointer because the information is stored as shown in  
20 Fig. 24. Template ID 2403 of a relation used by the fact  
is stored, so that the template ID can be obtained.

Information relative to the template is stored  
as shown in Fig. 25, so that the information can be  
obtained from template ID. A relational concept 2503 is  
25 stored, so that Fig. 25 shows a template of an attribute  
concept "industry". Accordingly, when the template ID  
2403 in Fig. 24 coincides with the template ID 2503 in  
Fig. 25, the fact identified by fact ID 2401 is a fact

1 expressed by a relation "type-of-industry". In the  
pointer 2504, information concerning the case order,  
information concerning case constraint concepts,  
information concerning postpositions in Japanese and  
5 information concerning prepositions in English are  
stored. These data are displayed in the order determined  
by the pointer. In Fig. 25, data are displayed in the  
order of attribute object case 2505, attribute concept  
2513 (in this case, "type-of-industry") and attribute  
10 value case 2517. The pointers 2506 and 2518 express case  
constraint concepts of respective cases. The case  
constraint concept of attribute object case 2505 is  
"company" 2511 and the preposition is "of" 2506. When  
there are a plurality of case constraint concepts, these  
15 are indicated by the pointer 2509. The case constraint  
concept of attribute value case is "type-of-industry"  
2523. Accordingly, this template shows the following  
sentence.

"Type-of-industry of [company] is [type-of-  
20 industry]"

The pointer 2406 in Fig. 24 indicates the  
contents of the cases of the template. "B Company" 2410  
and "electric company" 2416 are stored in attribute  
object case 2407 and attribute value case 2412, respec-  
25 tively. Because one case is filled with one concept,  
"single" 2408 is stored therein. When one case is filled  
with a plurality of concepts, the concepts are connected  
by the pointer 2409. When the relation between the

1 concepts means "A and B", "and" 2408 is stored therein.  
When the relation between the concepts means "set of A  
and B", "set" is stored therein. When the relation  
between the concepts means "A or B", "or" is stored  
5 therein. Accordingly, when the template ID 2401 in Fig.  
24 is equal to the template ID 2501 in Fig. 25, the fact  
in Fig. 24 expresses the following meaning.

"Type-of-industry of B company is electric  
company"

10 Fig. 24 shows the expression of a fact for  
attribute concept. A fact for verbal concept is expres-  
sed as shown in Figs. 26 and 27. This shows a fact  
expressing the following meaning.

"Taro Hitachi took doctorate at University A"

15 In step 6834, a judgment is made as to whether  
the template ID obtained by the step 6832 is in the list  
of template ID generated by the step 6810. When there is  
no template ID, the template ID is added to the list of  
template ID in step 6838. Then, the pointer to the list  
20 of fact ID is moved by one to check the next fact,  
whereafter the situation of the routine goes back to the  
step 6830. This procedure is repeated unless the pointer  
to the list of fact ID is NULL.

Thus, a list of relations using the concept  
25 "Company" can be obtained so that the relations are  
unique. In step 6850, the list of relations can be  
exhibited to the user in the form of a template 4601 as a  
condition allowed to be added to "company" 4603 as shown

1 in Fig. 46. The case filled with "company" in the tem-  
plate thus exhibited is expressed by a pronoun corre-  
sponding to the case, such as "its" 4611, "it" 4613 or  
the like. When the number of templates exhibited is so  
5 large that the templates cannot be put in one window, a  
scroll bar 4621 appears to indicate the rate of the  
exhibited templates to all candidate templates. Although  
this embodiment shows the case where relational templates  
are obtained from sentences using a concept as a condi-  
10 tion allowed to be given to the concept, templates  
allowed to use the concept can be exhibited as candi-  
dates. Fig. 23 shows the case where a list 2330 of  
templates allowed to use the concept is obtained on the  
basis of concept ID. The list of templates is held in  
15 each case in the same manner as the list of fact ID in  
Fig. 28.

In this embodiment, candidates for templates  
used in facts are exhibited because the templates are  
used in the process of generating a query. If a  
20 candidate selected from templates not used in facts is  
used in a query, the result cannot be fitted so that a  
large number of candidates are required. In this embodi-  
ment, however, templates of relations are extracted as  
candidates from facts. Accordingly, even if the user  
25 searches a large number of relations, a reduced number of  
relations having the possibility that results are  
obtained can be added as conditions. Further, the number  
of exhibited relations is reduced so that it is easy for

1 the user to find the conditions to be added. In the case where the invention is applied to the inputting of facts, a list of templates allowed to be used can be exhibited as a list of candidates.

5 Thus, the display of a verbal query and an attribute query allowed to be added can be performed.

In the following, the filtration of candidates will be described as a tenth embodiment according to the display method of the invention. When the number of  
10 relations exhibited in the restriction addition window is large, relations as candidates can be filtered in step 6860.

When, for example, a restriction is to be given to "Company" 4603 in a relation using "person" 4605 in  
15 Fig. 46, "person" is inputted in a focused concept input box 4631 in step 6870. In step 6910, a judgment is made as to whether the pointer to the list of template ID is NULL. When the pointer is not NULL, template ID pointed by the pointer is obtained in step 6920 and then a  
20 focused concept usable flag for indicating whether the template can use the focused concept is initialized to zero.

Then, a judgment is made as to whether the focused concept can be used in the case in the template.  
25 In the examination of the template in Fig. 25, a judgment in step 6940 is first made as to whether the pointer 2504 is NULL. When the pointer is not NULL, the case constraint concept (in this case, "company" 2511) of the



- 1 case pointed by the pointer is obtained in step 7010.  
Then, in step 7020, a judgment is made as to whether the  
focused concept is lower than the case constraint  
concept. When the focused concept is subsumed under the
- 5 case constraint concept, the focused concept is embedded  
in the position of the case constraint concept and then  
the focused concept usable flag is set to 1. Then, in  
step 7050, the pointer 2504 is moved by one and then the  
situation of the routine goes back to the step 6940.
- 10 This procedure is repeated unless the pointer is NULL,  
that is, before the examination of all cases is com-  
pleted. Here, with respect to the template in which at  
least one case can be filled with the focused concept,  
the focused concept usable flag is 1. In step 6960, a
- 15 judgment is made as to whether the focused concept usable  
flag is zero. When the flag is zero, the template ID  
obtained by the step 6920 is removed from the list of  
template ID in step 6970. In step 6980, the pointer to  
the list of template ID is moved by one to check the next
- 20 template and then the situation of the routine goes back  
to the step 6910. This procedure is repeated unless the  
pointer is NULL.

Templates as candidates are selected by  
performing matching of strings of characters for names of

- 25 all subconcepts as described above. In the restriction  
addition window 4601 in Fig. 46, conditions allowed to be  
added to "Company" 4603 are displayed without focusing.  
As a result, a large number of conditions are displayed.

1 In Fig. 47, conditions allowed to given to "company" are  
filtered to conditions allowed to embed "person". When  
the user wants to add conditions to "company" on the  
basis of "person", conditions can be filtered as  
5 described above.

Focused concepts allowed to be use are thus  
selected from the templates as candidates for restriction  
addition and displayed in step 6890. At this time, the  
concept "person" used for focusing is displayed in the  
10 case in the step 6890 as shown in "Its owner is [person]"  
(4701). Accordingly, the user can see what case can be  
filled with the concept used for focusing. When a  
sentence to be displayed in the query editing window is  
selected from candidates, the trouble required for  
15 resetting the focused concept as a concept in a case in  
the selected sentence can be omitted. Thus, filtration  
and user's selection of candidates can be facilitated.

The filtration (focusing) can be repeated.  
Fig. 48 shows the case where a filtration based on  
20 "University A" and a filtration based on "doctorate" are  
performed successively. "University A" and "doctorate"  
used for filtration are embedded in the candidate  
sentence 4801. Among case selection buttons in the case  
selection window, buttons 4803 and 4805 corresponding to  
25 cases filled with the concepts used for filtration, that  
is, corresponding to collection-in case and object case,  
have been selected initially.

Although this embodiment has shown the case

1 where focused concepts are inputted after all candidates  
are displayed once, the invention can be applied to the  
case where focused concepts may be inputted initially.

When a template of "establish" as a condition  
5 to be added is to be selected from focused candidates,  
the color of the button 4711 is changed by clicking the  
button through a mouse to thereby indicate the selection  
of the button in step 6750. Further, a case selection  
window 4721 appears to inquire what case among the cases  
10 of the template "establish" as a conditional sentence is  
to be added to the query. The buttons 4723 and 4739 are  
buttons for selecting whether cases corresponding to the  
buttons are used. In this case, the button 4723 shows  
the selected case. In step 6760, the state of selection/  
15 non-selection can be turned over in the same manner as a  
toggle switch by clicking these buttons. At this time, a  
case corresponding to the place 4725 where there is no  
selection button is a case using "company" as an object  
of restriction addition. This is because this case must  
20 be used.

When the initialization button 4731 is then  
clicked, the state goes back to the state existing before  
candidates are filtered.

When the addition button 4733 is clicked in  
25 step 6770, a new line 4901 is added to the query editing  
window 4900 and displayed as shown in Fig. 49 in step  
6780. Assuming now that there are some conditions to be  
added to "company" 5001 and "person" 5003, then, in step

1 6330,

"Its place is [Tokyo]" (5007) and

"It took [license] at [University A]" (5005)

are added as conditional sentences to "company" 5001 and

5 "person" 5003, respectively. This sentence modifies

"person" in the following sentence.

"It was established by [person]" (5004)

Accordingly, these two sentences express the following participial modification sentence.

10 "It was established by a person taking license at University A."

Sentences modifying concepts in the query can be added successively as query conditions in the manner as described above. Fig. 50 shows the state of the display in which addition is finished. An indented line in the query in the query editing window 5010 represents that the sentence in the indent line modifies the above sentence. When the invention is applied to inputting of facts, templates allowed to be used can be filtered by specific concepts or relations and exhibited.

15

20

The filtration of candidates can be thus performed.

The alteration of concepts allowed to be put in cases in conditions will be described as an eleventh embodiment according to the display method of the invention. In the previous embodiment, relations used for restriction addition and cases used can be selected but case constraint concepts are put in cases except the

25

1 cases using focused concepts because no case except the  
cases using focused concepts is not set with respect to  
the content thereof. Therefore, in step 6790, case  
elements are set. In Fig. 50, "license" 5005 is put in  
5 the object case of "take". When this is to be altered to  
"doctorate" 5023, in step 7210, the case requiring the  
alteration of the concept in the case in the query in the  
query editing window 5010, that is, the case filled with  
"license" 5005, is pointed. The current concept is  
10 automatically changed to "license" 5005, so that the node  
tree window is rewritten to a category allowed to be  
inputted in the case in step 7220. Fig. 50 shows the  
display just after the rewriting.

When a concept in a case in the query is to be  
15 changed in step 6620, the concept in the case requiring  
alteration of the concept is altered as the current  
concept and then a concept to be set as the content of  
the case is selected from the node tree window in the  
same manner as in the case where the object case of  
20 "take" is altered from "license" to "doctorate" at the  
time of restriction addition.

When a string of characters for a concept to be  
retrieved is inputted in the string input area 4241 for  
search, a concept having a string fitted to the input  
25 string as expression is retrieved and displayed in the  
node tree. Subconcepts of a concept can be further  
displayed by selecting "sub-concept display" from a pop-  
up menu displayed by clicking the right button of a mouse

1 in the concept in the node tree window. A desired  
concept can be displayed by repeating this procedure.

In this case, both the root concept in the tree  
and the anchor concept are "license" 5021. In step 7230,  
5 the current concept is altered to "doctorate" and object  
case of "take" is also altered to "doctorate" by clicking  
a mouse in "doctorate" 5023 in the node tree window 5020.  
When a plurality of concepts are to be put in one case, a  
pop-up menu is displayed by clicking a mouse in the case.  
10 For example, the pop-up menu contains:

"SET",  
"AND", and  
"OR".

When "SET" is selected, the meaning of the case  
15 in which a plurality of concepts, for example, A and B,  
are set is

"a set of A and B" which is displayed as  
(SET:A;B).

When "AND" is selected, the meaning of the case  
20 in which a plurality of concepts, for example, A and B,  
are set is

"A and B" which is displayed as (AND:A;B).

When "OR" is selected, the meaning of the case  
in which a plurality of concepts, for example, A and B,  
25 are set is

"A or B" which is displayed as (OR:A;B).

Fig. 51 shows the case where a plurality of  
concepts are set. In this drawing, there is shown a

1 query as follows: "What is company ? It was established  
by a set of H company and F company. It has laboratory  
in Tokyo and United State. The establishment of the H  
company is 1900 or 1910.". In the query, (SET:[F  
5 company];[H company]) 5101 expresses "a set of F company  
and H company", (AND:[Tokyo];[United States]) 5102  
expresses "Tokyo and United States", and (OR:[1900];  
[1910]) expresses "1900 or 1910". When a conditional  
sentence is further added to a plurality of concepts, a  
10 concept to which the conditional sentence is added after  
"co-occurrence" is displayed to make the relation or  
connecting relation clear. For example, in the drawing,  
the conditional sentence "The H company has laboratory in  
(AND:[Tokto];[United States])." 5105 modifies one concept  
15 "H company" among concepts in (SET:[F company];[H  
company]) 5101." When the conditional sentence modifies  
both "F company" and "H company", the conditional  
sentence is displayed as "The (SET:[F company];[H  
company]) have laboratory in (AND:[Tokyo];[United  
20 States]).

When the invention is applied to inputting of  
facts, concepts allowed to be put in cases in the facts  
can be altered.

The alteration of concepts allowed to be put in  
25 cases in conditions can be performed as described above.

In the following, addition of a case to a  
conditional sentence, deletion of a case in a conditional  
sentence and deletion of a conditional sentence will be

1 described as a twelfth embodiment according to the  
display method of the invention.

When case editing is required in step 6620,  
that is, when addition of a case to a conditional  
5 sentence in a query or deletion of a case from a condi-  
tional sentence is required, a pop-up menu is displayed  
by clicking a mouse in the head of the conditional  
sentence to be subjected to case addition/deletion in  
step 7110. When an item is selected in step 7130, a case  
10 selection window (4721 in Fig. 47) as used at the time of  
restriction addition is displayed in step 7140. At this  
time, cases which have been used in the query are  
displayed emphatically like the button 4722, whereas  
cases not used are displayed like the button 4739.

15 The state of selection/non-selection can be  
changed over like a toggle switch by user's clicking  
these buttons through a mouse. In step 7150, cases used  
in the query are added/deleted by clicking these buttons  
through the mouse. At the time of case deletion, a case  
20 can be also deleted by selecting an item from a pop-up  
menu displayed through clicking the mouse in the case in  
the query editing window.

In deletion of a condition once added, a  
conditional sentence to be deleted and conditional  
25 sentences added to concepts in the conditional sentence  
are deleted by clicking a mouse in the head of the  
conditional sentence in step 6640 and selecting an item  
from a pop-up menu in step 6650.



1           Addition of a conditional sentence, deletion of  
a case in a conditional sentence and deletion of a  
conditional sentence can be performed as described above.

          In the following, the display of a result will  
5   be described as a thirteenth embodiment according to the  
display method of the invention. In execution of retrieval,  
a concept to be retrieved in the query editing  
window is pointed by clicking a mouse in step 6680, so  
that an item is selected from a pop-up menu. Not only  
10 root concepts in a query but other concepts can be  
retrieved as long as the concepts are in the window.  
When, for example, "person" 5003 is pointed by clicking a  
mouse in Fig. 50 to execute retrieval,

          "Person which took license at University A" is  
15 retrieved. When there is any concept fitted to the query  
condition, a result list window 5200 is displayed. A  
result list is shown in Fig. 52. In this case, "Tanaka  
X" 5205, "Hitachi Y" 5206 and "Yamada Z" 5207 are  
concepts (in this case, "person") fitted to the query  
20 condition. The number of concepts fitted to the query  
condition is displayed as "The number of matched  
concepts: 3" 5201 in an upper portion of the window.

          When an item is selected from the "view" menu  
5202 by pointing a button corresponding to a string of  
25 characters, result information in detail can be displayed  
by combining facts accumulated on the knowledge base with  
the resulting concept. It is assumed now in the drawing  
that each of the toggle buttons for "Tanaka X" 5205 and

1 "Hitachi Y" 5206 is in a selection state and that the  
toggle button for "Yamada Z" 5207 is in a non-selection  
state. When an item is selected from the menu, specific  
licenses (which "Tanaka X" and "Hitachi Y" took at  
5 University A) expressed in facts with respect to "Tanaka  
X" and "Hitachi Y" in which each of the toggle buttons is  
in a selection state are embedded in corresponding cases  
in the query and displayed in the result browser window.

When an item is selected from the "selection"  
10 menu 5203, all toggle buttons corresponding to resulting  
concepts can be turned to "selection" or to "non-  
selection".

The display of results can be performed as  
described above.

15 According to the present invention, in an  
information storage and retrieval system using a  
conceptual relation model for expressing knowledge by  
concepts and relations defined between concepts, fact  
information expressed by both concepts and relations  
20 stored in a knowledge base is displayed on the basis of  
templates defining the significant structures of cases  
and template patterns so that concepts attendantly stored  
in the templates are displayed together with preposi-  
tions/postpositions in the form of a string of charac-  
25 ters. As a result, not only sentences based on  
polynomial relations can be inputted correspondingly to  
the templates but the sentences can be expressed as  
registered facts in the form of a language as near as a

1 natural language as possible. Furthermore, strings of  
characters for prepositions/postpositions can be stored  
regardless of the language displayed. Furthermore, an  
effect arises in that there is no generation of sentences  
5 making no sense, because inputting is based on templates  
and a hierarchy of concepts. Furthermore, sentences can  
be inputted by using a pointing device, so that a user  
inexperienced for operating a keyboard can input  
sentences easily.

10 Furthermore, guidance concerning concepts  
allowed to be inputted can be displayed by using a  
multi-window function, so that the user can select  
concepts speedily to generate sentences.

In addition, in the case where the number of  
15 facts to be displayed is larger than a threshold, the  
system can automatically select facts to be displayed to  
make it possible to use a limited view area effectively.

WHAT IS CLAIMED IS:

1. An information storage and retrieval system using a concept relation model for representing knowledge in terms of concepts and relations defined between the concepts, which comprises:

means for inputting fact information represented in terms of concepts including conceptual concepts representing things and relational concepts defined between said conceptual concepts, according to the structure of templates, each of which defines semantic information peculiar to said relational concepts and constituent elements;

means for storing said fact information inputted by said input means, for interacting with a user for generating a retrieval request on the basis of said stored fact information, and for retrieving requested one of said conceptual concepts; and

means for displaying a fact window for said fact information and a node tree window for a hierarchy of said conceptual concepts and said relational concepts to perform at least one of the inputting of said fact information and the retrieval of said requested conceptual concept.

2. An information storage and retrieval system according to Claim 1, wherein said relation concepts include verbal concepts representing verbs, and attribute concepts representing attributes.

3. An information storage and retrieval system

according to Claim 2, wherein said conceptual concepts include noun concepts representing nouns, unit name concepts representing names of numerical values, and unit concepts representing units, and wherein said system further comprises means for managing said conceptual concepts and said attribute concepts by is-a relations and for managing said conceptual concepts by part-whole relations.

4. An information storage and retrieval system according to Claim 3, wherein said system further comprises a knowledge base for storing a concept relation model for managing and expressing said verbal concepts and said attribute concepts in said relational concepts by is-a relations.

5. An information storage and retrieval system according to Claim 2, wherein said system further comprises means for defining semantic priority order for standard cases of said verbal concepts, and for managing said standard cases.

6. An information storage and retrieval system according to Claim 1, wherein template patterns are respectively defined for said templates, and wherein said system further comprises means for expressing semantic information in a pseudo-natural language by using said template patterns.

7. An information storage and retrieval system according to Claim 1, wherein said system further comprises a knowledge base for storing a concept relation

model for expressing strings of characters for prepositions/postpositions added to semantic information of said relational concepts, independent of languages.

8. An information storage and retrieval system according to Claim 3, wherein said system further comprises means for retrieving fact information stored in terms of said relational concepts and at least one conceptual concept by using super-concepts with respect to said relational concepts.

9. An information storage and retrieval system according to Claim 1, wherein said system further comprises means for focusing (filtering) said templates on the basis of semantic information of said templates to select templates permitting said requested conceptual concept to enter at least one case thereof.

10. An information storage and retrieval system according to Claim 1, wherein said system further comprises means for focusing (filtering) said templates on the basis of semantic information of said templates to select templates corresponding to said relational concepts.

11. An information storage and retrieval system according to Claim 3, wherein said system further comprises means for storing said noun concepts and said unit concepts in terms of names each expressed by at least one string of characters, and for managing said noun concepts and said unit concepts by using one of said strings as a representative name.

12. An information storage and retrieval system according to Claim 2, wherein said system further comprises means for storing said relation concepts in terms of names each expressed by at least one string of characters, and for managing said relational concepts by using one of said strings as a representative name.

13. An information storage and retrieval system according to Claim 2, wherein said system further comprises means for storing said verbal concepts in terms of conjugational etyma each expressed by a string of characters, and for storing information concerning strings of characters corresponding to conjugations thereof and difference in kind of the conjugations.

14. An information storage and retrieval system using a concept relation model for representing knowledge in terms of concepts and relations defined between the concepts, which comprises:

means for inputting fact information represented in terms of concepts including conceptual concepts representing things and relational concepts defined between said conceptual concepts, according to the structure of templates, each of which defines semantic information peculiar to said relational concepts and constituent elements;

means for storing and managing said fact information on the basis of said semantic information defined by said templates; and

means for displaying a fact window for said

fact information and a node tree window for a hierarchy of said conceptual concepts and said relational concepts to perform the inputting of said fact information.

15. An information storage and retrieval system according to Claim 14, wherein said system further comprises means for storing, as said fact information, a plurality of conceptual concepts expressing at least one sense (semantic information).

16. An information storage and retrieval system according to Claim 14, wherein said system further comprises means for storing general information added to conceptual concepts expressing semantic information in said fact information.

17. An information storage and retrieval system according to Claim 14, wherein said system further comprises means for storing indefinite information added to conceptual concepts expressing semantic information in said fact information, so that said indefinite information expresses that the expression of said conceptual concepts as semantic information is indefinite.

18. An information storage and retrieval system according to Claim 14, wherein said system further comprises means for storing semantic information contained in said fact information, by quoting other fact information.

19. An information storage and retrieval system according to Claim 15, wherein said system further comprises means for storing other fact information



modifying conceptual concepts, added to the conceptual concepts expressing semantic information in said fact information.

20. An information storage and retrieval system according to Claim 15, wherein said system further comprises means for storing exclusion information added to at least one conceptual concept expressing semantic information in said fact information, so that said exclusion information expresses the exclusion of at least one conceptual concept from subconcepts of said conceptual concept.

21. An information storage and retrieval system using a concept relation model for representing knowledge in terms of concepts and relations defined between the concepts, which comprises:

means for inputting fact information represented in terms of concepts including conceptual concepts representing things and relational concepts defined between said conceptual concepts, according to the structure of templates, each of which defines semantic information peculiar to said relational concepts and constituent elements;

means for storing said fact information inputted by said input means, for interacting with a user for generating a retrieval request on the basis of said stored fact information, and for retrieving requested one of said conceptual concepts;

means for displaying a fact window for said

fact information and a node tree window for a hierarchy of said conceptual concepts and said relational concepts to perform at least one of the inputting of said fact information and the retrieval of said requested conceptual concept;

means for selecting a conceptual concept used in said fact information and the retrieval condition, for extracting candidate sentences allowed to use said selected conceptual concept by using said templates, and for displaying said candidate sentences;

means for selecting at least one candidate sentence from said candidate sentences;

means for selecting a case used in said fact information and said retrieval condition from cases in said selected candidate sentence; and

means for embedding said conceptual concept in said selected case and for displaying said conceptual concept embedded in said selected case.

22. An information storage and retrieval system according to Claim 21, wherein said system further comprises means for inputting semantic information based on a natural language sentence having a plurality of cases by using a pointing device.

23. An information storage and retrieval system according to Claim 21, wherein said system further comprises means for selecting a conceptual concept used in said fact information and said case of said retrieval condition from conceptual concepts displayed in said node

tree window by using a pointing device.

24. An information storage and retrieval system according to Claim 23, wherein said system further comprises means for obtaining an uppermost conceptual concept allowed to enter a case defined in said template by pointing the conceptual concept in said fact information and said retrieval condition through said pointing device, for rewriting the tree-form display of said node tree window to a tree-form display drawn with said uppermost conceptual concept and subconcepts of said conceptual concept as the central place thereof, and for substituting a conceptual concept for the conceptual concept in said case by pointing said conceptual concept allowed to enter said case through said pointing device.

25. An information storage and retrieval system according to Claim 24, wherein said system further comprises means for displaying conceptual concepts in the form of a tree while discriminating between conceptual concepts allowed to be replaced and conceptual concepts forbidden to be replaced.

26. An information storage and retrieval system according to Claim 21, wherein said system further comprises means for displaying candidate sentences allowed to be used in terms of the pointed conceptual concept or relational concept, by focusing (filtering) said candidate sentences.

27. An information storage and retrieval system according to Claim 26, wherein said system further

comprises means for displaying said focused candidate sentences on the prerequisite that a case allowed to use the conceptual concept used for the focusing (filtration) is selected from cases in said focused candidate sentences.

28. An information storage and retrieval system according to Claim 21, wherein said system further comprises means for generating a retrieval condition for modifying a conceptual concept by selecting said conceptual concept in said retrieval condition and inputting a conditional sentence, and for displaying said retrieval condition.

29. An information storage and retrieval system according to Claim 21, wherein said system further comprises means for deleting a conditional sentence by pointing said conditional sentence through a pointing device to re-display the retrieval condition.

30. An information storage and retrieval system according to Claim 21, wherein said system further comprises: means for extracting cases defined in a template corresponding to a conditional sentence by pointing said conditional sentence through a pointing device, and for displaying cases allowed to be used in said conditional sentence; and means for performing addition and deletion of cases in said conditional sentence by pointing the displayed case through said pointing device, and for displaying the cases.

31. A display method in an information storage and

retrieval system using a concept relation model for representing knowledge in terms of concepts and relations defined between the concepts, which comprises the steps of:

inputting fact information represented in terms of concepts including conceptual concepts representing things and relational concepts defined between said conceptual concepts, according to the structure of templates, each of which defines semantic information peculiar to said relational concepts and constituent elements;

storing the inputted fact information and retrieving a requested conceptual concept on the basis of said stored fact information; and

displaying a fact window for said fact information and a node tree window for a hierarchy of said conceptual concepts and said relational concepts to perform at least one of the inputting of said fact information and the retrieval of said requested conceptual concept.

32. A display method in an information storage and retrieval system using a concept relation model for representing knowledge in terms of concepts and relations defined between the concepts, which comprises the steps of:

inputting fact information represented in terms of concepts including conceptual concepts representing things and relational concepts defined between said

conceptual concepts, according to the structure of templates, each of which defines semantic information peculiar to said relational concepts and constituent elements;

storing the inputted fact information and retrieving a requested conceptual concept on the basis of the stored fact information;

displaying a fact window for said fact information and a node tree window for a hierarchy of said conceptual concepts and said relational concepts to perform at least one of the inputting of said fact information and the retrieval of said requested conceptual concept;

selecting a conceptual concept used in said fact information and the retrieval condition, extracting candidate sentences allowed to use said selected conceptual concept by using said templates, and displaying said candidate sentences;

selecting at least one candidate sentence from said candidate sentences and selecting a case used in said fact information and said retrieval condition from cases in said selected candidate sentence; and

embedding said conceptual concept in said selected case and displaying said conceptual concept embedded in said selected case.

33. A display method in an information storage and retrieval system according to Claim 32, wherein semantic information based on a natural language sentence having a

plurality of cases is inputted by using a pointing device.

34. A display method in an information storage and retrieval system according to Claim 32, wherein a conceptual concept used in said fact information and said case of said retrieval condition is selected from conceptual concepts displayed in said node tree window by using a pointing device.

35. A display method in an information storage and retrieval system according to Claim 34, wherein an uppermost conceptual concept allowed to enter a case defined in said template is obtained by pointing the conceptual concept in said fact information and said retrieval condition through said pointing device; the tree-form display of said node tree window is rewritten to a tree-form display drawn with said uppermost conceptual concept and subconcepts of said conceptual concept as the central place thereof, and wherein a conceptual concept is substituted for the conceptual concept in said case by pointing said conceptual concept allowed to enter said case through said pointing device.

36. A display method in an information storage and retrieval system according to Claim 35, wherein conceptual concepts in the form of a tree are displayed while discriminating between conceptual concepts allowed to be replaced and conceptual concepts forbidden to be replaced.

37. A display method in an information storage and

retrieval system according to Claim 32, wherein candidate sentences allowed to be used in terms of the pointed conceptual concept or relational concept are displayed by focusing (filtering) said candidate sentences.

38. A display method in an information storage and retrieval system according to Claim 37, wherein said focused candidate sentences are displayed on the pre-requisite that a case allowed to use the conceptual concept used for the focusing (filtration) is selected from cases in said focused candidate sentences.

39. A display method in an information storage and retrieval system according to Claim 32, wherein a retrieval condition for modifying a conceptual concept is generated by selecting said conceptual concept in said retrieval condition and inputting a conditional sentence and is displayed.

40. A display method in an information storage and retrieval system according to Claim 32, wherein a conditional sentence is deleted by pointing said conditional sentence through a pointing device to re-display the retrieval condition.

41. A display method in an information storage and retrieval system according to Claim 32, wherein cases defined in a template corresponding to a conditional sentence are extracted by pointing said conditional sentence through a pointing device to display cases allowed to be used in said conditional sentence, and wherein addition and deletion of cases in said condi-



tional sentence are performed by pointing the displayed case through said pointing device to display the cases.

42. An information storage and retrieval system substantially as herein described with reference to the accompanying drawings.

43. A display method in an information storage and retrieval system substantially as herein described with reference to the accompanying drawings.



**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number

GB 9219791.2

**Relevant Technical fields**

- (i) UK CI (Edition K ) G4A (AUD)  
(ii) Int CI (Edition 5 ) G06F 15/40

**Search Examiner**

S J PROBERT

**Databases (see over)**

(i) UK Patent Office

(ii)

**Date of Search**

12 NOVEMBER 1992

Documents considered relevant following a search in respect of claims

1-43

| Category<br>(see over) | Identity of document and relevant passages | Relevant to<br>claim(s) |
|------------------------|--|-------------------------|
| A                      | US 4611298 (SCHULDT) see whole document    | 1, 14, 21<br>31, 32     |

| Category | Identity of document and relevant passages | Relevant to claim(s) |
|----------|--|----------------------|
|          |  |                      |

### Categories of documents

**X:** Document indicating lack of novelty or of inventive step.

**Y:** Document indicating lack of inventive step if combined with one or more other documents of the same category.

**A:** Document indicating technological background and/or state of the art.

**P:** Document published on or after the declared priority date but before the filing date of the present application.

**E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.

**&:** Member of the same patent family, corresponding document.

**Databases:** The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).